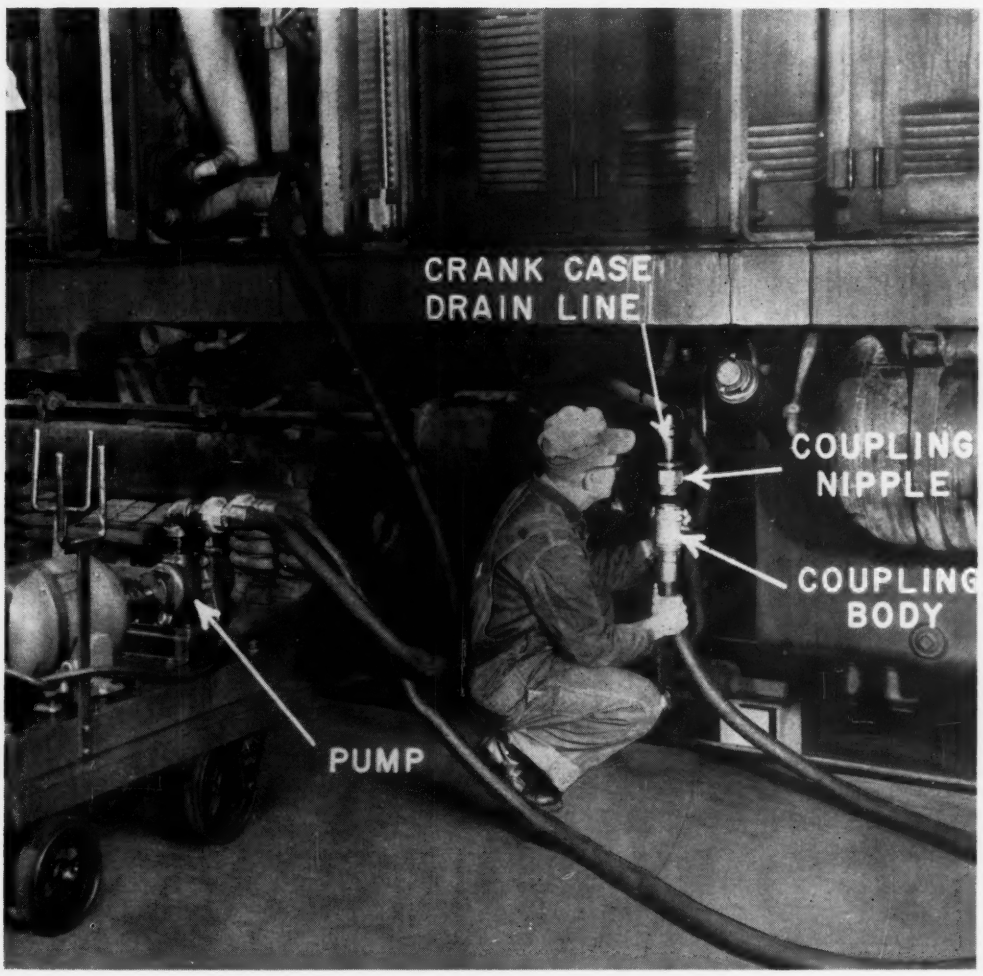
Vol. 13, No. 2 February, 1957

LUBRICATION ENGINEERING

RESEARCH APPLICATION EDUCATION MAINTENANCE



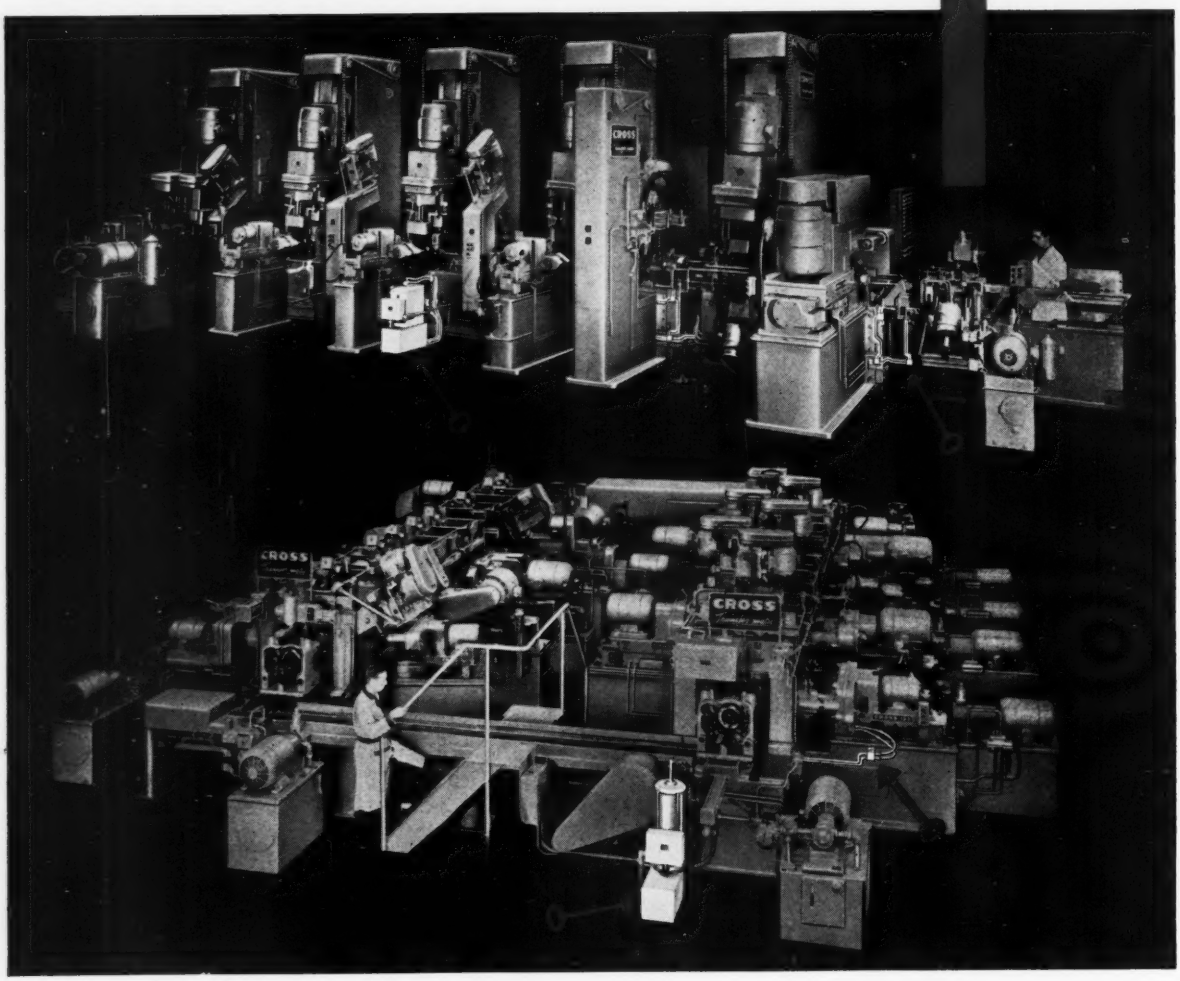
Pre-Lubrication of a Diesel Engine after Overhaul

(Cover Story, p. 71)

JOURNAL OF THE AMERICAN SOCIETY OF LUBRICATION ENGINEERS

Lubrication by Farval is automatic, too, on these Cross Transfer-matics

FARVAL—
Studies in Centralized Lubrication
No. 194



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Affiliate of The Cleveland Worm and Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.

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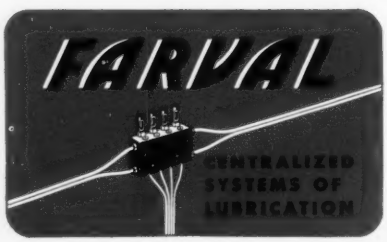
Wherever you can see these Farval manifolds, dual lubricant lines, and central pumping station, you know a machine is being properly lubricated.



LUBRICATION ENGINEERING

RESEARCH · APPLICATION · EDUCATION · MAINTENANCE

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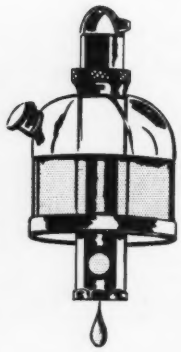


Highlights of Articles Scheduled for Coming Issues!

A Dual Purpose Film Strength Additive for Engine Crankcase Oils

Engineers and chemists have suspected that agents soluble in mineral oil possess the property of forming a very thin or molecular film on sliding metal surfaces and are capable of improving film strengths required for engine lubrication. In evaluating a new film strength improver it was found that film strength increases by adsorption onto metal surfaces and the additive reacts or alloys with metals just before seizure conditions permitting metal flow until high points are leveled and seizure obviated.

Disinfection of Soluble Oil Emulsions

Emulsifiable oils are complex chemical mixtures. They contain petroleum, lard oil, sperm oil, rape seed oil, tall oil, petroleum sulfonate, naphthenate, oleate, resinate, isopropopanol, and various glycol ethers. Two schools of thought exist for the causative agents of dermatoses: (1) The growth of bacteria in soluble emulsions which invades the skin, and (2) Potentially pathogenic bacteria, normally present on the skin, invade the weakened epidermis to establish infection. Disinfectants recommended by the suppliers of soluble oils have been tested and a comparative list of recommended additives for disinfecting emulsions is presented. The tests presented show that the addition of disinfectants by some manufacturers has serious limitations and that some disinfectants recommended for addition by the user may be useless in controlling bacterial growth.

A New Method for the Determination of Attitude & Eccentricity in Journal Bearings

Some of the most difficult yet most important measurements to be made in bearings are those of determining the attitude, eccentricity, and film thickness. A new method of measurement is described which measures the motion between a rigidly-supported shaft and a floating bearing. Three types of instruments were used to measure this motion. Since the work was accompanied with a stability analysis of journal bearings, only eccentricity ratios in the range from 0 to 0.5 were investigated.

Use of Rolling Contact Bearings in Low Viscosity Liquid Metal Lubricants

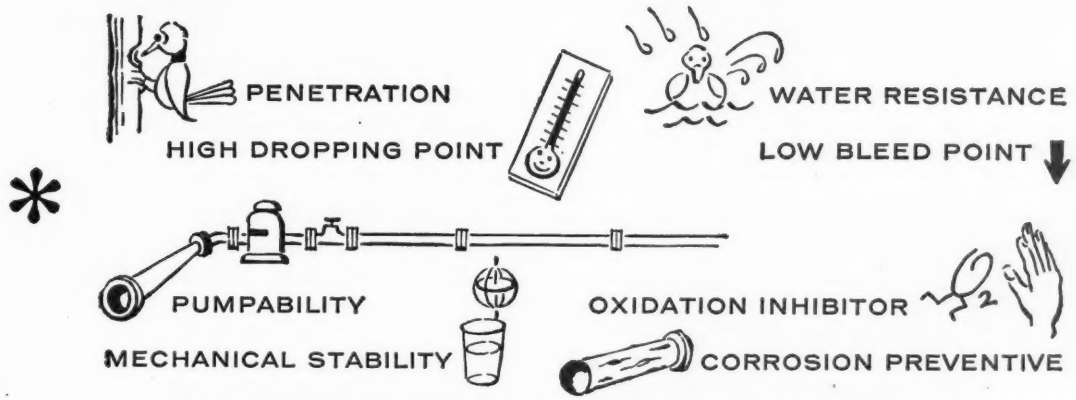
Tests were conducted on rolling contact bearings submerged in and lubricated by either liquid sodium-potassium alloy or liquid sodium to determine the effect of thrust load on the bearing with respect to bearing life. Various materials of construction and bearing design were used, and the effects of these variables were measured.

Numerical Solution of Reynolds' Equation for Sector Thrust Bearings

A method of solving the Reynolds' equation using digital computer techniques has been developed to predict sector bearing performance. The results compare favorably with experiment and known analytical solutions. The investigation indicates that good design criteria may be established for sector thrust bearings with arbitrary geometries, and possibly very accurate predictions may be obtained if the Reynolds' and energy equations can be solved simultaneously by this technique.

Grease Chemists:

Only Lithium Hydroxide-Base Grease Offers the Correct Balance of Critical Properties* Necessary for Proper Lubrication Performance



* The action of lithium as a gelling agent dominantly controls the first four of these functional properties. Fatty acids, oil and auxiliary additives influence the last four. Lithium does not adversely affect any of these critical properties.

There are definite manufacturing and marketing advantages in producing lithium-based grease. Inventory control is but one of them. Being a true multipurpose product, only one lithium soap grease is needed to lubricate your car: chassis, water pump, wheel bearings and universal joints. Often, several single-purpose lubricants are replaced in special industrial applications. Of equal significance is Lithium Corporation's acceptance in the field: over 10 years' production experience supplying lithium hydroxide to the grease industry. Add to this our unsurpassed production facilities and you are assured of a reliable source of consistently uniform quality LiOH, available from inventory for immediate shipment. Since we are equally interested in developing better lithium products, why not get in touch with us? A card or letter will bring immediate response.

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LUBRICATION ENGINEERING

RESEARCH APPLICATION EDUCATION MAINTENANCE

Volume 13, No. 2
February, 1957

A Salute To The Engineering Profession

That week of February, in which we commemorate George Washington's birthday, has been set aside for the past several years to recognize the engineer for his contributions to the development of this country. This Week is selected because George Washington was recognized as the first engineer in this nation.

"Engineering . . . America's Great Resource," has been chosen as the theme for the 1957 Engineers Week. What could be a more timely theme with the increasing recognition that our real resources are not under ground, but are walking around above ground — in the minds and attitudes of our people? The engineering skills and knowledge are the resources that will be applied to complex situations which will develop for America an expanding and continuing growth based on technological developments.

Engineers generally, are much too prone to sit back and let others receive credit for their fine achievements. How often has one seen the dedicatory stone on an engineering achievement with the name of a dignitary or philanthropist boldly inscribed, and with little or no mention of the individual that made such achievement possible. While it is true that there will be considerable national recognition of Engineers Week through radio, television, newspaper and magazine articles, the real public relations value lies within the engineer himself.

The public's impression of engineering is created by the engineer; friends, neighbors and acquaintances gain their impression from the individual engineer they know. The great engineering discoveries of the past ages and amazing technological developments of the Twentieth Century have swept us to our highest level of material well-being. The necessities of life are commonplace, and Americans these days enjoy many advantages which were considered luxuries only 20 years ago.

Our living standards are high, but there can be no final plateau — man is ever demanding more.

What will the future bring? What challenges await the engineer? What rewards does the future hold for him?

His overall goal, of course, is evident . . . the balanced improvement of man's world, socially and materially. To this end, the engineer must play an important dual role: that of an effective servant of mankind, and at the same time, that of a responsible leader.

It is obvious that technology must advance — and it will — but the engineer's responsibility goes beyond the realm of technology. He must take a more active part in the social aspects of man's well-being, beyond the level of material improvements. He must use his engineering ability to understand and solve problems in the area of civic and governmental affairs.

Engineers must enlist greater public participation in engineering progress by interpreting technical matters more clearly to the non-technical public. Generally, this is where the engineer has failed. To enhance the professional recognition that should rightfully be the engineer's, requires that he become active in civic affairs and explain the engineering phenomenon which has enshrouded the profession. Let your friends and acquaintances know that you are an engineer — help them with their civic problems — and interpret the engineering profession to the layman and greater recognition will be accorded this most dignified profession.

Calvert L. Willey
Administrative Secretary

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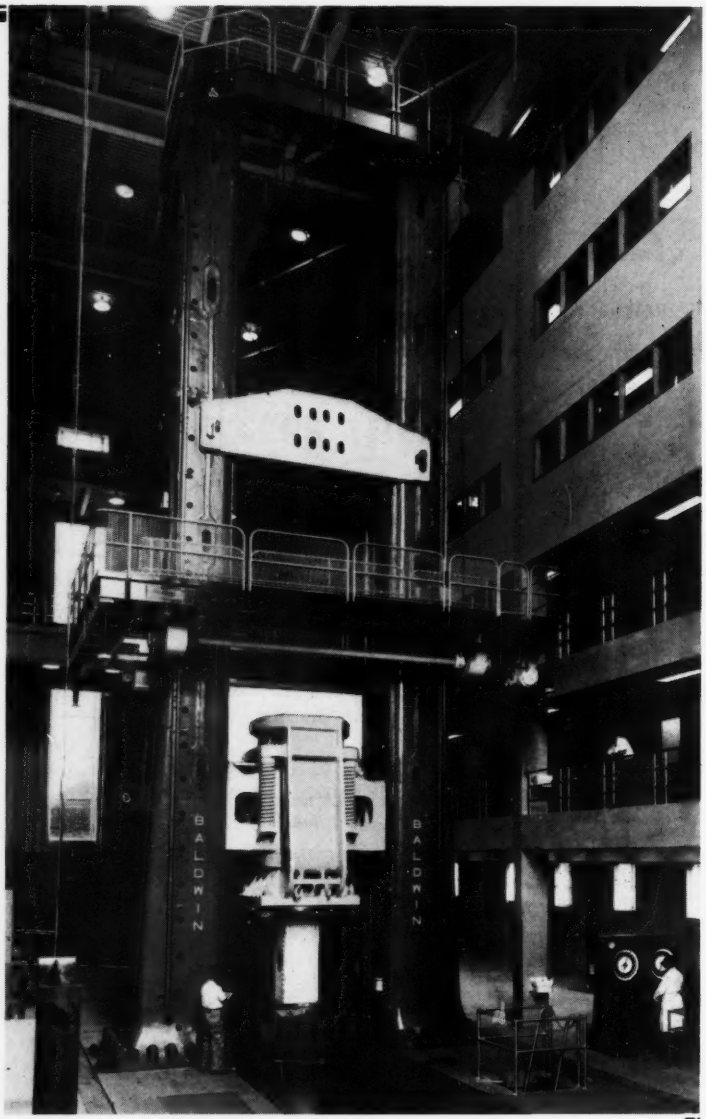
When engineers of Baldwin-Lima-Hamilton Corporation designed and built this mammoth 5,000,000 pound universal testing machine for Lehigh University, they realized from years of experience that extreme testing pressures could cause destructive "stick-slip" action in the test specimen grips and the loading screws.

That is why MOLYKOTE Lubricant was generously applied to both the grips and the screws before the first trial specimen was broken in this giant universal tester.

Baldwin engineers, as well as engineers throughout industry, have come to depend upon MOLYKOTE Lubricant in extreme pressure applications.

MOLYKOTE is manufactured from the purest molybdenum disulfide powder available to industry today. It is compounded under laboratory supervision to retain this purity in the manufacturing process and has achieved an enviable reputation for overcoming the toughest lubrication problems in industry.

MOLYKOTE Lubricant is distributed throughout the world, wherever industry faces the obstacles of providing adequate lubrication in extreme pressure and extreme temperature applications.



5,000,000 pound B-T-E Universal Testing Machine installed in Fritz Engineering Laboratory, Lehigh University, Bethlehem, Pa. Built by Baldwin-Lima-Hamilton Corporation, Eddystone, Pa.

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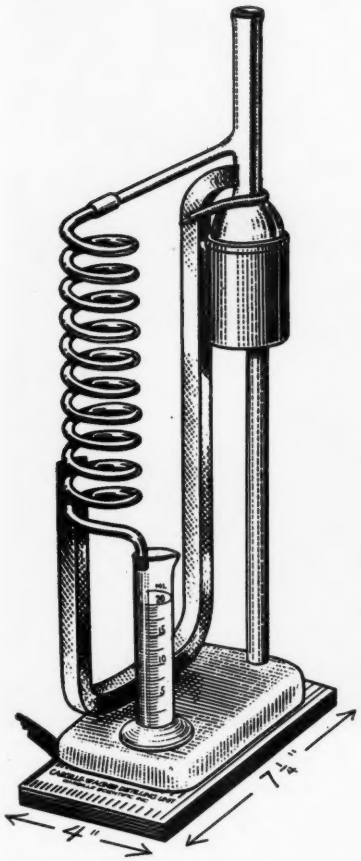


Distilling Apparatus. The Cargille-Wagner Distilling Unit (pictured above) provides several new features that facilitate small distillations. Recommended for distillations of solvents, petroleum products, beverages, organics, the unit requires no tripod, no ring stand, no clamps, no water connections. It is easily set up, easily operated, and needs only to be plugged into the line current. Six of these units can be operated at one time on laboratory table space only 36″ wide. The base, only 4″ wide, is fitted with two uprights. One supports a copper cooling coil, and the other has a special electric heater rigidly attached. The curvature of the heater cavity fits snugly around a 25 ml. Pyrex distilling flask to promote heating efficiency. A 20 ml. cylinder is used for measuring out liquids to be distilled, also for receiving distillates. (Cargille Scientific Inc., 117 Liberty St., N. Y. C.)

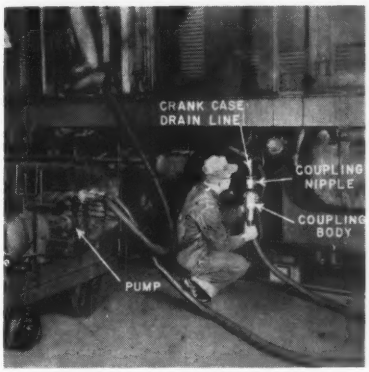
Oil-Resistant Air Hose. "Duraprene," a lightweight two-braid hose constructed to meet the company's rigid specifications of "oil resistant," is applicable to a wide range of industrial uses where air pressures of up to 200 psi are encountered. Presently available in sizes up to and including ⅜″, samples are available upon request. (Hamilton Rubber Mfg. Corp., Trenton, N. J.)

Coolant Clarifier. A new grinding and honing coolant clarifier, Model 115 (pictured above), uses centrifugal force to remove both free abrasive grains and metal particles from coolants. In this way, bulky magnetic equipment as well as costly filter replacement is eliminated. Model 115 requires but six square feet of space for installation, has a dirt-holding capacity of over three gallons, and handles all types of coolants. (The DeLaval Separator Co., Poughkeepsie, N. Y.)

Plastic Gasket Material. Vacuum line sealing problems are being solved by a new Plastic Gasket material. Users report that by adding 1/64″ film or coating to flange faces and gasket surfaces, vacuum line leakage is reduced to a minimum. Any slight leakage which may occur after line has been in service for some time can be corrected without dismantling flanges by simply applying 1/32″ of Plastic Gasket material around the outside surface of the flange where they meet with the gasket. Available in two formulations: one for air, steam, water, mild chemicals; the other for gasoline, oil, solvents, etc. Where flange faces are unmarred and come together evenly, the material can be used alone without any other type gasketing material. It is non-hardening, and flanges are easy to dismantle even after years of service. (Flexrock Co., 3603-F Filbert St., Philadelphia 1, Pa.)

New Aviation Oil. Gulf Oil Corp. has announced plans to market a newly perfected detergent aviation oil for use in all types of aircraft engines. The new product is a blend of oils to which has been added an anti-foam agent and a detergent dispersant effective for both high and low temperature operation. The new formulation will be made available in SAE 30, SAE 40, and SAE 50 viscosity grades. (Gulf Oil Corp., Pittsburgh, Pa.)

Cover Story

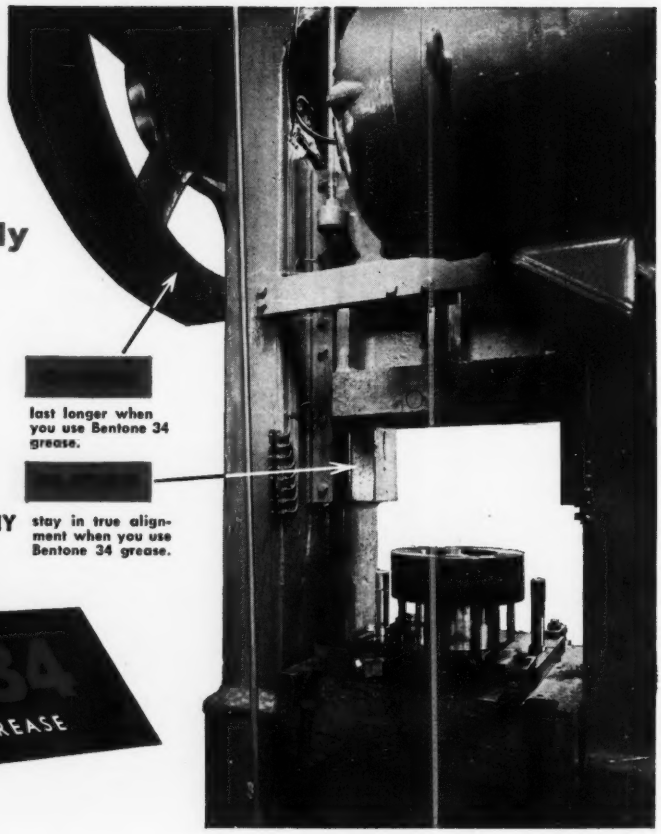


Pre-Lubrication of a Diesel Engine after Overhaul. The photograph on the front cover of this issue shows how a Quick-Seal coupling permits "snap-on" connection of portable oil-circulating pump to engine crankcase. A check-valve inside the coupling prevents leakage from the line when disconnected. Operator is shown retracting coupling collar which permits coupling body to be inserted on coupling nipple. Release of collar then locks both parts of coupling together, completing piping connection from crankcase to pump. (Submitted by Titeflex, Inc., 10 Hendee St., Springfield 4, Mass.)

Bentone* 34 Based Grease

Takes Shock Load Easily on 160 TON Press

Heavy duty presses run fair and true under high pressures and shock loads when moving parts are lubricated with greases compounded with Bentone* 34. The F. Hohlfelder Co., Cleveland, Ohio, found by test the most economical, best-lasting grease is one compounded using Bentone 34.



[redacted] last longer when you use Bentone 34 grease.

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*T.M. Reg.

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ASLE News Notebook

Compiled by
R. D. McCormick

Executive Reports

Minutes of the October 8, 1956 meeting of the Executive Committee were approved. The Executive Committee recommends that the Board approve expenses of the Detroit Section for the Annual Meeting not to exceed $2500.

Income to the Society was reported slightly in excess of $1000 more than that received during 1955 for the year ending December 31, 1956. It was recommended that certain funds of the Society be transferred to different Savings & Loan institutions to gain additional interest benefits offered by these institutions. The committee recommended that the Board authorize the Administrative Secretary to sign all drafts, checks, or other orders for the payment of money, notes, or other evidences of indebtedness issued in the name of the Society. It was recommended that the 1957 budget as altered by the Executive committee be accepted by the Board. Financial obligations with the Engineering Societies' Placement Service were terminated subject to concurring agreement by the Boards of the respective groups. The Administrative Secretary was instructed to solicit classified job advertisements for the journal from readers and those interested in seeking applicants.

The Executive Committee recommended that music and/or entertainment be substituted for the speaker at the Annual Meeting banquet.

Treasurer's Report

Receipts from the Joint Conference in October grossed $2,624 after payment of registration service fees. Against this, ASME printing expenses amounted to $800.00 and ALSE printing expenses totaled $1,440.00 allowing net income after expenses of $384.

The proposed budget was presented to the Board on January 9, 1957. Total income was expected to reach in excess of $125,000 and total disbursements to reach $128,000 causing a deficit of in excess of $3000, which would be taken from reserve funds.

Administrative Secretary's Report

Mr. Calvert L. Willey was introduced to the Board as the new Administrative Secretary. Mr. Willey was formerly associated with the National Society of Professional Engineers as Assistant to the Executive Director. He replaces W. P. Youngclaus, Jr., who left ASLE to accept a similar position with the ASQC in November.

Mr. Willey reported that a monthly membership report will be made to all officers, directors, and membership chairmen tabulating new membership, delinquencies, and other information of use in promoting membership.

Eastern Region

Most of the Sections have made plans for educational courses to be held this year. Included are: Baltimore, Boston, Buffalo, New York, and Connecticut each with one course and Philadelphia with two, one to be held at York, Pa. Wheeling, W. Va., is planning a course and Syracuse has no plans for a course at the present time.

An outline of a planned membership drive has been sent to each Section and most of the Sections have responded with enthusiasm. New Sections are being investigated for York, Pa. and the Huntington-Charleston, W. Va. areas. A survey questionnaire has been sent to the Sections to assist the regional vice-president in coordinating Section activities.

Central Region

The Dayton and Cincinnati Sections have made mailings to industries where potential membership may be available. Programs for the Dayton, Cincinnati, and Cleveland Sections have been scheduled for the year and all appear to be of excellent quality.

Central Ohio has received its charter and has scheduled a technical meeting starting the fourth Monday of February.

Kingsport and Youngstown Sections will be visited by the regional vice-president in the future so that a report on their activities for the year can be available for the Annual Meeting of the Board.

Midwestern Region

New Section activities include work in the Dallas-Ft. Worth area. The first meeting of this Section is planned for the immediate future.

Chicago Section is planning a one-day symposium in September in cooperation with another technical society. The symposium will treat Lubrication Engineering and the promotion of interest in the field.

Interested students of the Illinois Institute of Technology and Northwestern University will be invited to attend a meeting of the Chicago Section sometime in the future to encourage the students to pursue engineering and to recognize the lubrication engineering function. Chicago is also working on a TV program to appear on the local educational TV channel to publicize the work of ASLE and the importance of the function to modern industry.

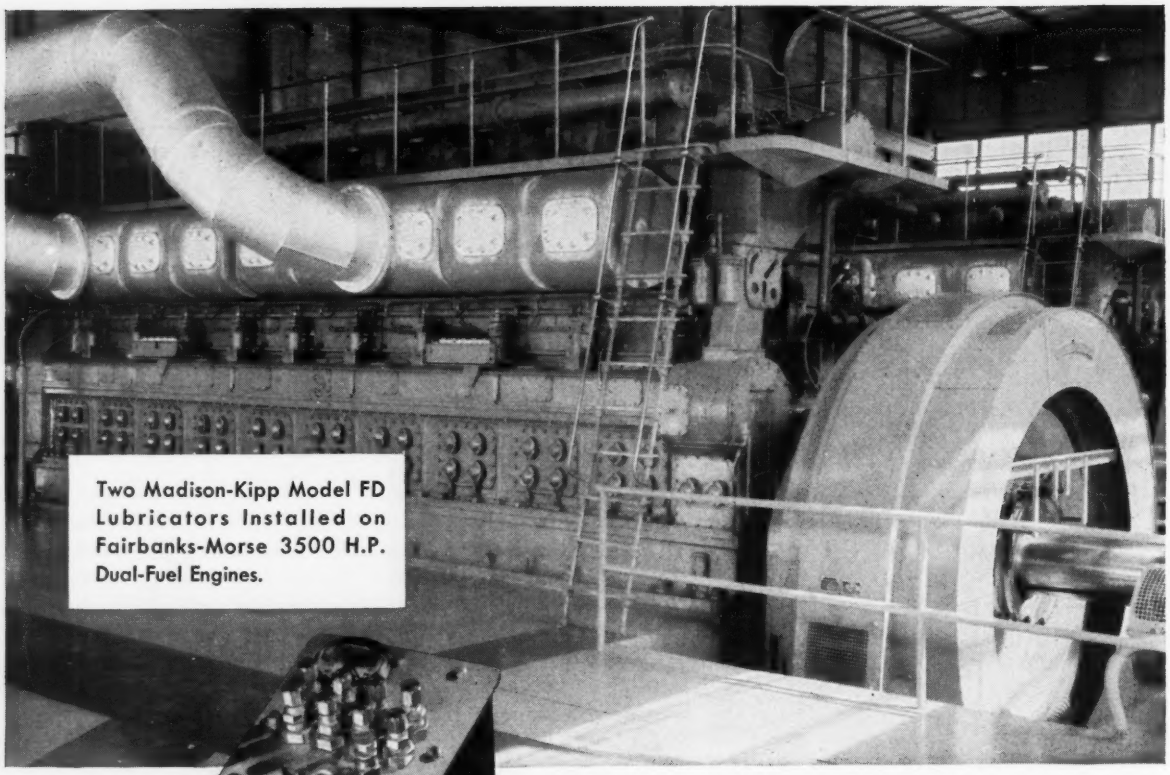
Western Region

Los Angeles held a half-day conference in which the Executive Committee discussed ways to stimulate increased activity among the Section and to accurately define the work of the Section officers.

About 50 people have enrolled in the lubrication engineering course cosponsored by the Los Angeles Section and the University of Southern California Extension Division.

Prospects for a new Section in the Seattle area are well under way with plans for the first meeting to be held in January.

Mr. John Hood has been appointed area representative for the Seattle area and Mr. Roger Dishington has been appointed area representative for the Southern California area. Mr. Dudley Thomas has been appointed area



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representative for the Rocky Mountain area and has contacted 28 prospective members in and around Salt Lake City interested in starting a new Section. Unaffiliated members or prospective members interested in becoming a part of these new Section activities should contact the area representatives for further information on meeting dates of the new Sections. (See ASLE Directory, this issue.)

CANADIAN REGION

No Report

Committee Reports

TECHNICAL ADVISORY BOARD

Chairmen have been appointed for all technical committees and the committees are functioning. Names of committee chairmen will be found in the ASLE Directory printed in this issue. The Non-Ferrous Metals industry committee has been started under the chairmanship of Mr. L. H. Decker.

Each committee has been instructed to conduct a literature and experience survey to determine any gaps in the state of the art and to define the need for research projects. Once active research projects have been defined, active participation of industry will be sought.

A subcommittee of TAB, which has been studying the Industrial Lubricant Viscosity Classification System, has been instructed to prepare a consolidated statement of views for presentation at the June ASTM Symposium. This statement will be submitted to the TAB for approval by ballot before the next Board of Directors meeting.

The Gear Lubrication Committee has proposed a two-day symposium to be held in the middle of 1959 treating the specific subject gear lubrication.

Various technical and industry committees of the TAB are performing services to the Society. Included in these services are the preparation of abstracts by subcommittees of each committee to be published in *Lubrication Engineering* and the processing of requests for technical information from individuals, government agencies, and industry.

BY-LAWS

W. H. Millett has resigned as chairman of the By-Laws committee. No active work has been accomplished on the revision of the By-Laws since the last meeting.

JOINT LUBRICATION CONFERENCE

Next meeting of the conference committee is scheduled during the April Annual Meeting in Detroit to be followed by a meeting in July at Cleveland. A final report on the finances from the October 1956 conference indicated approximately $300 was available after expenses for promotion and planning of the 1957 conference at Toronto, Ontario, Canada, October 7-9.

TELLERS COMMITTEE

No Report

NOMINATIONS

A. B. Two, J. Roshinshas, B. T. Harding, and H. W. McCulloch were presented to the Board as nominees for the two offices of directors to be filled by the election of new officers in April. Mr. McCulloch has asked to have his name removed from the ballot in order to devote full time during the next year to the job of Annual Meeting committee chairman. Directors hold office for 3 years.

Mr. L. O. Witzenberg was nominated to fill the office of Industrial Director, for the period 1957-59.

Additional nominees to be elected by the Board of Directors during the April meeting will be announced in a future issue of the journal.

A. B. Wilder, W. H. Fowler, Jr., E. R. Booser, and W. P. Youngclaus, Jr., discuss the duties of the administrative secretary just after Bill Youngclaus announced his resignation. Recommendations made at this conference assisted in the selection of Mr. C. L. Willey as the new administrative secretary.

EDUCATION

The 1957 Lubrication Engineering Course, held concurrently with the April Annual Meeting, is almost complete and includes much new material not previously presented in past courses. Completed details and speakers for the course will be announced in the program to be published in the March issue of Lubrication Engineering.

AWARDS

Nominees for the various ASLE awards are being screened by the committee and a formal recommendation will be made at the April board meeting.

MEMBERSHIP

A gain of 144 members has been obtained since September 30, 1956.

NEW SECTIONS

Two new Sections, Duluth-Iron Range and Central Ohio were chartered in November. Additional Sections are being developed and will be chartered as soon as they have fulfilled all requirements.

INDUSTRIAL MEMBERSHIP

No new Industrial Members have been added during the past 6 months.

PROJECTS

No Report

JOURNAL BEARING RESEARCH

No Report

ANNUAL MEETING

Host Section committee chairman, J. A. Brady, and several of the Detroit Section members reported on the local activities and plan to attract a large percentage of the Detroit area industrial population. Mrs. J. A. Brady, chairman of the Ladies' Program reported on the program scheduled to make the ladies' activities equally attractive to wives of the members and guests attending the Annual Meeting.

Entertainment has been substituted for the speaker normally presented at the Annual Meeting Banquet. This year music and dancing will be provided for members and guests attending the banquet in addition to the important awards announcements.

An advance registration cocktail party, sponsored by the Detroit Host Section, is planned for the Sunday afternoon preceding the Annual Meeting. Full details of the program will be published in the March and April issues of the journal.

EXHIBIT ARRANGEMENTS

Contracts for 35 exhibits booths have been accepted and additional booths are being made available to meet the demand for exhibit space.

ANNUAL MEETING SITES

No Report

EDITORIAL COMMITTEE

Monthly publication of the journal began with the January issue. In the past year several new features have been added, and new features of interest to the operating personnel within the plant are planned for 1957.

ABSTRACTS

Preparation of abstracts for the journal has progressed very well. Rules governing the preparation of the abstracts, which are prepared by subcommittees of the technical and industry committees, are almost complete and full coordination for this activity has been assumed by W. E. Campbell, committee chairman. A a result of the excellent help provided in past months by A. A. Raimondi, vice-chairman of the TAB, the committee is abstracting regularly all literature in the field for publication as a service to the Society and subscribers of the journal.

PROGRAM

Mr. C. R. Lewis presented the complete program for the technical sessions to be presented at the Annual Meeting. Of the 60 papers planned for the meeting, more than 20 have been received for preparation of preprints. The complete program is being published each month in the journal. As corrections to the program are made and more information is available it will be incorporated into the program section of *Lubrication Engineering*.

INDUSTRY RELATIONS

No Report

INDUSTRIAL REPRESENTATIVE

No Report

HANDBOOK ADVISORY

No Report

ORGANIZATION & OPERATIONS

M. E. Merchant offered his resignation as committee chairman and John Boyd was appointed to this post by President Booser. Mr. Merchant reported by letter that he had reviewed the recommendations submitted by C. R. Schmitt relative to the Industrial Representative Committee and endorsed the recommendations. Activities of the O & O Committee will be reactivated as quickly as possible to permit preparation of the operations manual treating the duties of the President, Vice-President at Large, Regional Vice-Presidents, Directors, Secretary, and the standard agenda for board meetings. The operations manual for the Treasurer has been completed during the past year.

A. B. Wilder presents a wristwatch to Bill Youngclaus on behalf of the ASLE staff and members of the Chicago Section.

Board Actions

By motion of the Board, the minutes of the October 10, 1956 meeting were approved. The budget, as altered by the Executive Committee, was approved by the Board. Mr. Willey was given authorization to sign all checks, drafts, or other orders for the payment of money, notes, or other evidences of indebtedness issued in the name of the Society. Withdrawal of funds from the Reserve Account will require the signature of two officers.

The directors authorized the Finance Committee to provide for expenses of the Detroit Section for the Annual Meeting not to exceed $2500.

J. O. McLean and S. R. Calish, Jr. were requested to prepare a proposal for setting up a permanent research fund for the Society.

The report of the Nominations Committee was accepted and the Administrative Secretary was instructed to prepare the ballot by action of the Board.

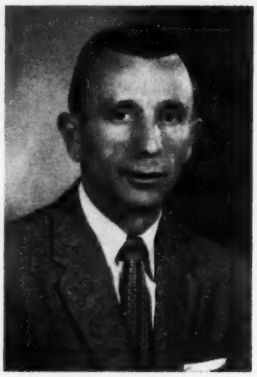
Awards to be presented at the Annual Meeting banquet will be made by the Awards Committee instead of the Board as a result of board action.

Next meeting of the Board was scheduled for April 15, 1957 at the Sheraton-Cadillac Hotel, Detroit, Michigan. Necessary elections, only, will be held during this meeting. All other business will be conducted during the second meeting to be held on Wednesday, April 17, 1957. All newly elected officers and directors will be invited to attend the second meeting.

Following the recommendations of the Executive Committee, the Administrative Secretary was authorized to contact and investigate publishers representatives and to engage their services as space salesmen for advertising in the journal. The West Coast area was to be committeed for sales and Mr. Willey is to recommend specific action to be taken for other areas of the country.

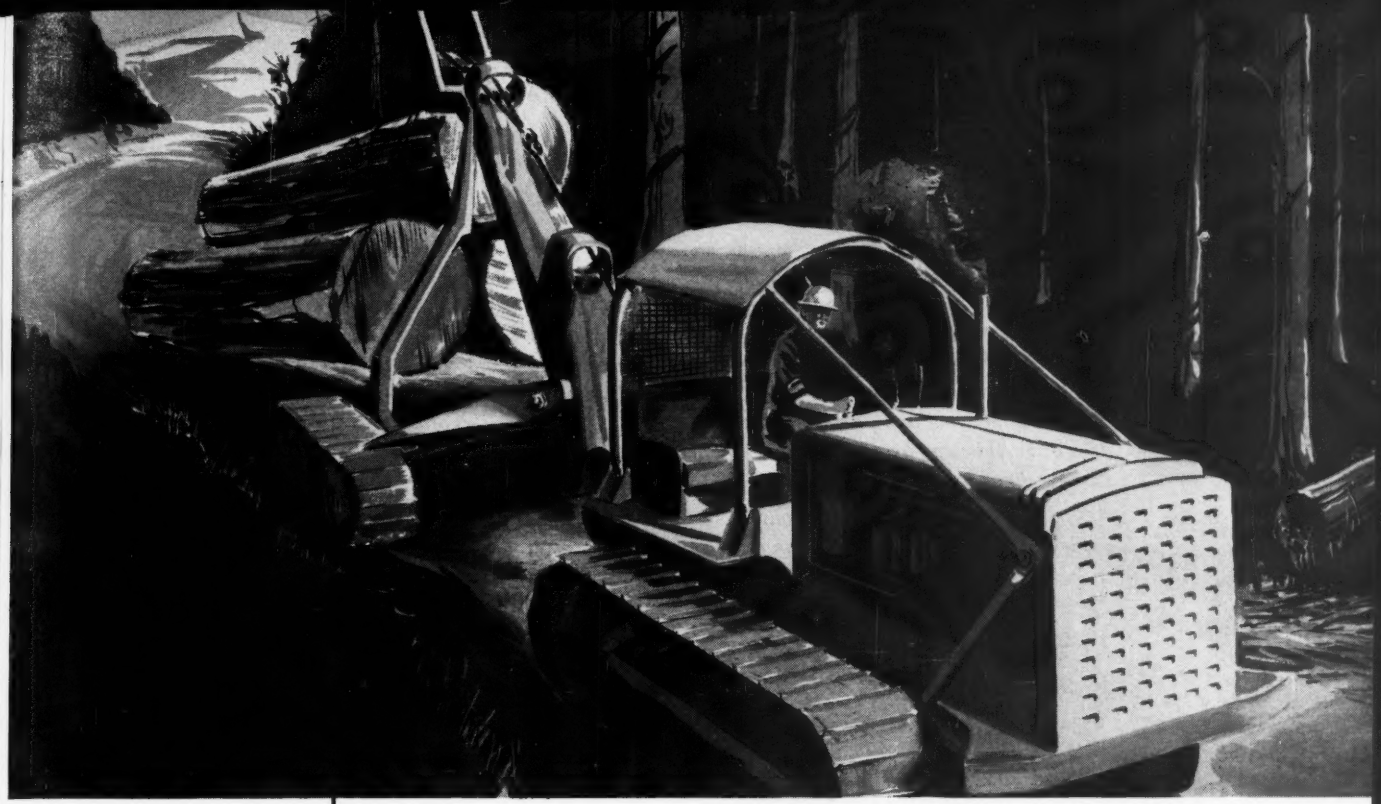
The Board moved that the directory of members not include any listing by company or industry after a discussion of problems which might result if such dual listing were made.

New Administrative Secretary Appointed



Calvert L. Willey

The Board of Directors have announced the appointment of Mr. C. L. Willey as the new Administrative Secretary of ASLE. Mr. Willey was formerly associated with the National Society of Professional Engineers in Washington, D. C., as assistant to the Executive Director. His work with NSPE included meeting planning and coordination, membership promotion, vocational guidance, economic research, surveys involving the expenditure of industrial research funds, funding arrangements for the new NSPE headquarters building, and the development of special brochures. Mr. Willey has also had experience in management consultation work while employed by the Clifton Corp. of Washington. He has worked for the National Security Agency and associations in developing personnel recruiting standards, classification, and market research, and has supervised special research for the Central Intelligence Agency. He is active in the U. S. Naval Reserve and holds the rank of Lieutenant. Mr. Willey is a graduate of the University of Maryland.



SUBSTANTIAL SAVINGS in downtime and maintenance costs have been experienced by many users of estersil greases in heavy-duty equipment.

FARM TRACTORS and other equipment lubricated with estersil greases are better protected against dirt, water and rough going because these greases stand up better even under the most adverse operating conditions.

COAL MINE OPERATORS report that heavy-duty mining machinery lasts longer with reduced grease consumption and maintenance costs when lubricated with estersil greases.

IN HIGH TEMPERATURE APPLICATIONS also, estersil greases are outstanding. They have been efficiently used in enameling oven conveyor setups operating at 500°F. in 15-minute cycles.

Du Pont Estersil GT offers outstanding advantages to grease users and compounders

The tremendous benefits of estersil greases have been proved in actual service.

For example, take a look at the ways Du Pont Estersil GT (grease thickener) can help you make a better grease with advantages that have unusual sales appeal.

1. Excellent shear stability—Even under prolonged high-shear, high-temperature operating conditions, greases made with estersil GT show exceptional resistance to thinning.

2. Superior oxidation stability—Estersil greases are almost as stable as their base oils and require no antioxidants under most service conditions.

EVEN IF IMMERSED in boiling water, estersil greases stand up for long periods without physical breakdown.

3. Water resistance—Each minute estersil particle is protected by a chemical "raincoat." This water-repellent characteristic makes estersil greases tolerant to water with little change in consistency.

ESTERSIL GT greases stand up unusually well even under the combined action of intense heat and vigorous mechanical working.

4. Unusual thermal stability — Estersil greases are non-melting. And even extreme temperature variations produce little change in their consistency.

5. Superior handling qualities—Greases thickened with estersil GT can be *more easily handled* in almost any application. This is because the unusually satisfactory thermal and mechanical stability permits use of a softer grease. Write us for samples and additional technical information.

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HENRY CORT *made a vital and far-reaching contribution to the steel industry when he patented his rolling process in England, in 1783. Before Cort designed and built a practical rolling mill, tilting hammers had been used to produce iron bars. This laborious process produced only about one ton of bars in 12 hours. Cort first shingled his iron into half blooms at welding temperature, then reheated and passed the hot slabs through grooved rollers of his own design. In this way he was able to produce no less than 15 tons of bars in a 12 hour period.*

While not the first to attempt rolling, Henry Cort's successful process justly earned him the title "father of the rolling mill."

Great Names in Steel Making #IV

Henry Cort's rolling mill followed a pattern as old as steel making. Whenever the need has become great enough, the right men have always developed the proper process or product to meet it.

In the modern field of industrial lubrication one thinks of such developments as the "E. P." lubricants which made today's high speed rolling mills practicable, of "Palmoshield" which freed America from dependence on imported palm oil, and of the wire drawing and cable lubricants which Ironsides engineers have originated in answer to compelling needs.

Keeping pace with 64 years of progress in steel rolling has made Ironsides' "Gear Shield" synonymous with satisfactory roll neck lubrication. So much so, that others frequently refer to their lubricants as "gear shields," even though Gear Shield is the exclusive trade mark of The Ironsides Company.

That steel men recognize this contribution is evidenced by the fact that nearly every major steel producer uses "Gear Shield" lubricants.

Today's rolling mills, so far advanced beyond Henry Cort's pioneer process, demand equally high standards in lubricants. Ironsides engineers work closely with superintendents, lubrication engineers and rollers on problems of temperature, pressure, pumpability and water repellency. Ingenuity and research are put to work until a completely satisfactory answer is found. For example, Ironsides roller bearing Shield, developed to meet the need for an extreme pressure lubricant, has load-bearing capacity in excess of bearing manufacturers' standards, and carries the approval of leading bearing makers as a result.

Ironsides engineers are prepared to "custom tailor" lubricants for the specific conditions and preferences of the individual mill. We will supply these specialized lubricants in any quantity from pail to tank car.

If you have a problem, our engineers would like to help you lick it. Their experience is at your service, without obligation. Address, or phone, The Ironsides Company, Columbus 16, Ohio.

By the makers of Palmoshield
"the palm tree that grows in Ohio"

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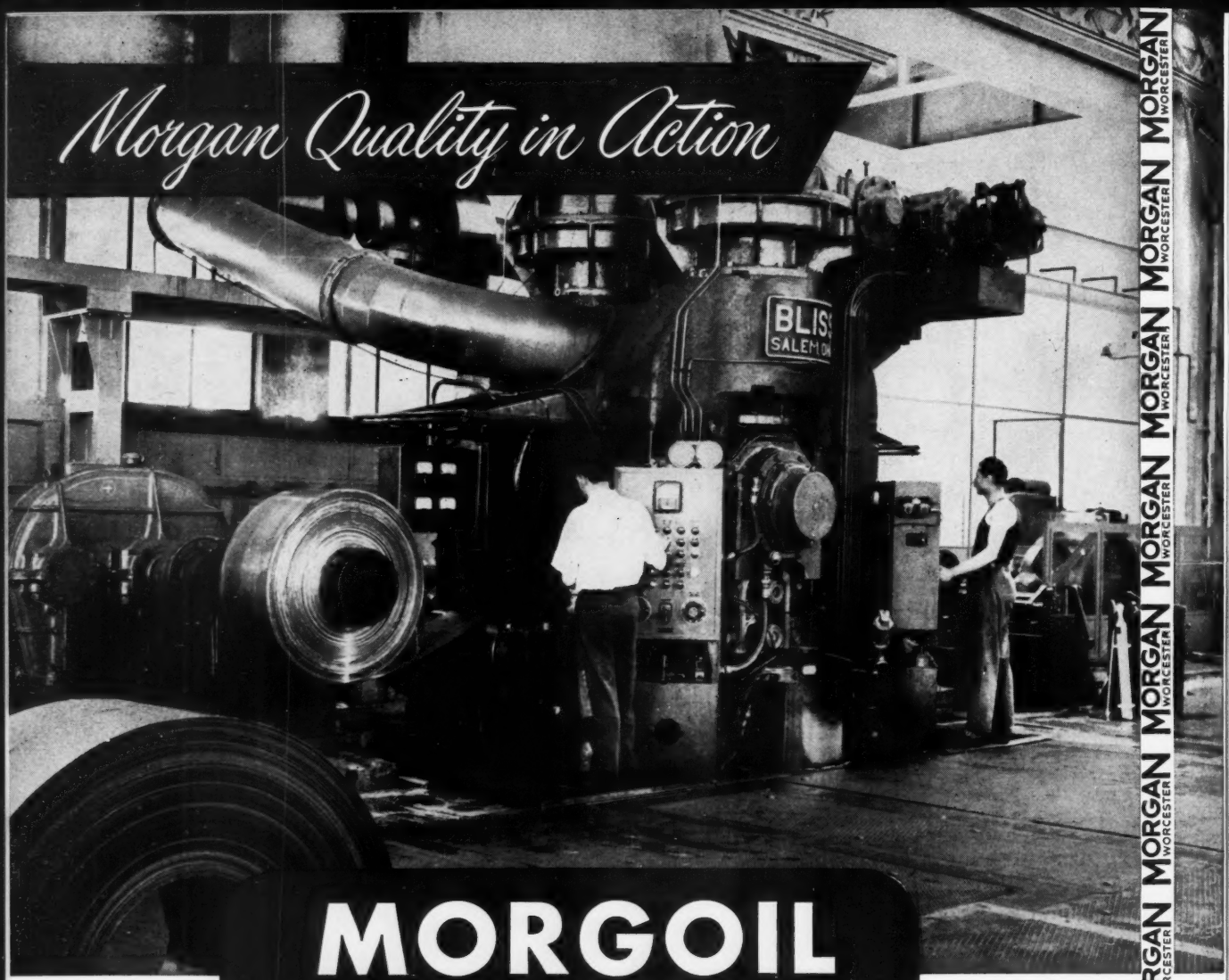

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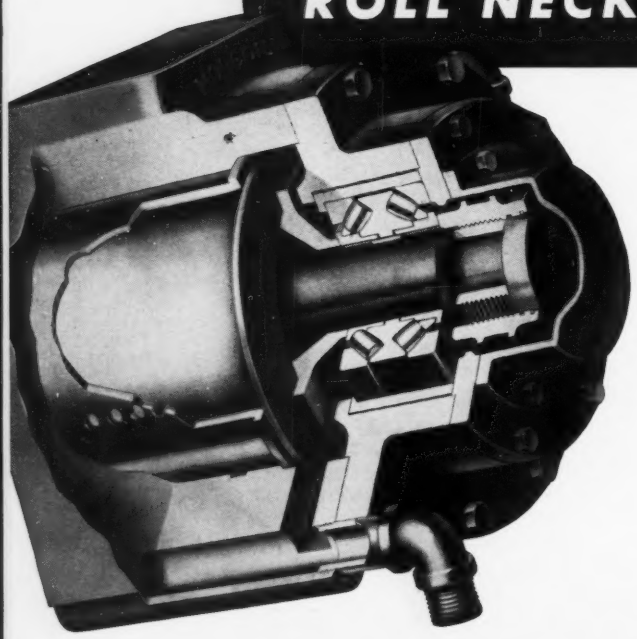
ROLL NECK BEARINGS



These 26″-90 MORGOIL Bearings are operating in a 10½″ & 30″ x 30″ single stand four high reversing cold mill at Lombarde Falck in Milan, Italy. Hot mills or cold mills, ferrous or nonferrous, at home or abroad, MORGOILS give the best roll neck bearing performance at the lowest cost.

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Lube Lines

by A. F. Brewer*

PUMPABILITY

Pumpability in lubrication can apply to either an oil or grease. Obviously a lubricant must remain pumpable throughout the period of operation of the machine it is to serve, or the objective of positive lubrication may be adversely affected. Furthermore, it normally will be impracticable to assume an arbitrary scale for pumpability — too much will depend upon the characteristics of the machine, the range of operating temperatures, and the structural features of the lubricating system.

It is for this reason that most of the research in regard to pumpability has, of necessity, had to be of laboratory nature. This does not presume the use of miniature test apparatus; on the contrary, full-size lubricating devices arranged so as to simulate actual operating conditions are used. Obviously it would be difficult to run a low-temperature pumpability test on a blast furnace centralized grease lubricating system, or on an overhead crane.

The petroleum industry considers the importance of pumpability when it applies the dewaxing and filtration processes to petroleum oils in the refinery. These treatments lower the observable cloud and pour points by retarding formation of wax crystals at reduced temperatures. This can be particularly effectual in refrigeration compressor lubrication, or for low-temperature engine starting. The viscosity must not be forgotten, however, because a viscosity-pour effect or relationship develops at low temperatures which definitely affects the pumpability of the oil.

Under normal conditions there is more leeway as to pumpability when choosing an oil than when a grease is involved. Lubricating oils up to the SAE 30 range are pumpable considerably below 0°F. Also, there is a wider range of oils available according to viscosity, pour point, base, nature of refinement, and additive content. Furthermore, it is practicable to blend a heavier oil with one of like characteristics but lower viscosity, when greater fluidity and pumpability of the resultant blend is desirable under low-temperature operations. A classic example is the idea of adding kerosene to engine oil to facilitate engine starting where ultra-low temperatures are involved.

The pumpability characteristic in grease lubrication did not really become of consequence until centralized pressure came into the picture. When the simple compression grease cup was the chief means of maintaining grease lubrication, the ordinary lime soap chassis grease sufficed to provide usually dependable lubrication. Operating conditions in those days were considerably less severe than prevail today. Speeds and loads were not too extreme, and very high temperatures were not too often encountered. Some grease leakage was expected; in fact, the familiar "collar of grease" around the outside of a bearing was a good indication that there was enough grease in the clearance; the grease collar also provided a seal to prevent entry of abrasive dust and dirt. A number 1 or 3 cup grease was the usually-accepted lubricant for this service.

Changes in design, however, prompted a new look at the type of grease when increased speeds, pressures, and better seals required a more dependable product. Then grease research became a major activity in practically every petroleum research laboratory. Along with the resultant improvements which led to the sodium soap, mixed base, barium and lithium compositions and, later, the use of stabilizing additives such as anti-oxidants, came the developments in centralized pressure as a means of lubrication. The die was cast, the question of *pumpability* came into prominence. With a lubricating device capable of serving a considerable number of bearings via transmission piping from a central source of supply, obviously the grease had to be workable enough to be forced through the lines under the available pressure and, virtually, regardless of temperature drop, otherwise a starved bearing could result.

A variety of conditions related to manufacture can affect the pumpability of any lubricant. Table I details these and indicates their relative importance.

Another interesting table (pertaining to operating and contructional features) can be helpful, especially to management, when it is necessary to select an oil or grease of adequate pumpability (see Table II).

It is all very well to know how readily the lubricant will flow, according to its indicated pumpability as determined in the laboratory, but the conditions under which it must be pumped in service are equally important. These must be evaluated by the lubrication engineer in accordance with the importance of the machine and its relation to the production line. If it means the purchase of a premium-grade lubricant of particularly low-temperature pumpability characteristics, he should impress this fact upon his management. Obviously the insurance value which the additional cost may buy is well worth the price.

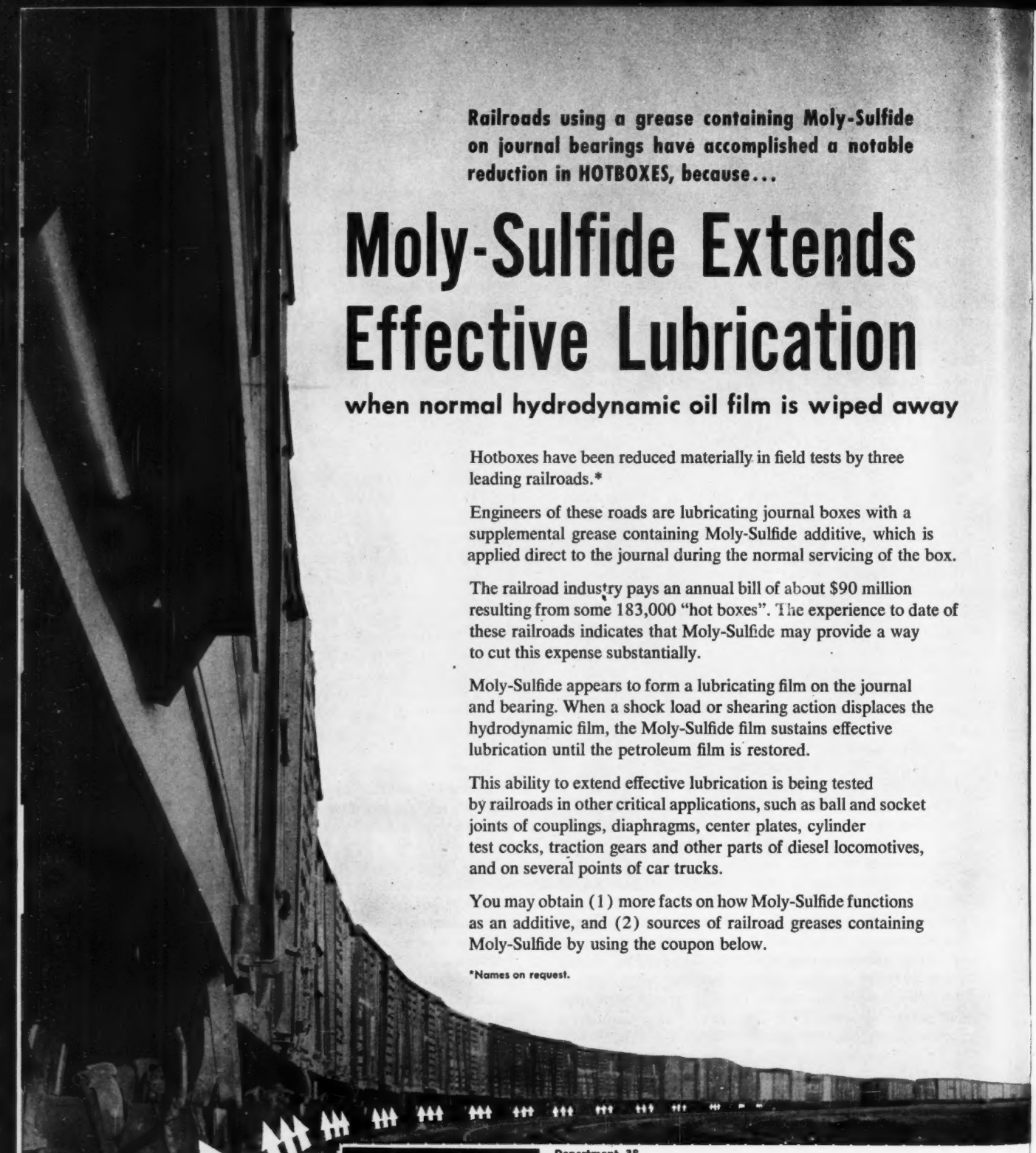
Table I

Oil	Grease
Source or base.	Percent of soap.
Viscosity.	Type of soap.
Cloud or pour points.	Viscosity of mineral oil.
Relation of viscosity to pour.	Pour point of mineral oil.
Presence of fatty oil compounds (as in steam cylindler oils).	Dropping point.
Use of additives such as pour depressants or VI improvers.	Working, in course of manufacture (indicated by penetration).
	Nature of manufacturing process.

Table II

Type of bearing.
Method of sealing to prevent leakage (remembering that the lubricant is applied under pressure).
Type of lubricating system.
Pressure under which lubricant is pumped.
Minimum operating or pumping temperature.
Length of lubricant transmission piping.
Inside diameter of such piping.
Are such pipes jacketed to insulate against low temperature effect.
Are parallel steam heating lines provided to prevent congealing of lubricant in transmission piping at low temperatures.
Provisions to prevent system from becoming air bound to interfere with flow of lubricant.

*Consultant, and Author of *Basic Lubrication Practice.*



Railroads using a grease containing Moly-Sulfide on journal bearings have accomplished a notable reduction in HOTBOXES, because...

Moly-Sulfide Extends Effective Lubrication

when normal hydrodynamic oil film is wiped away

Hotboxes have been reduced materially in field tests by three leading railroads.*

Engineers of these roads are lubricating journal boxes with a supplemental grease containing Moly-Sulfide additive, which is applied direct to the journal during the normal servicing of the box.

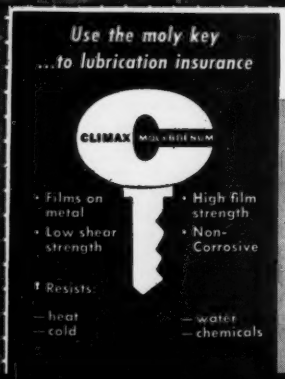
The railroad industry pays an annual bill of about $90 million resulting from some 183,000 "hot boxes". The experience to date of these railroads indicates that Moly-Sulfide may provide a way to cut this expense substantially.

Moly-Sulfide appears to form a lubricating film on the journal and bearing. When a shock load or shearing action displaces the hydrodynamic film, the Moly-Sulfide film sustains effective lubrication until the petroleum film is restored.

This ability to extend effective lubrication is being tested by railroads in other critical applications, such as ball and socket joints of couplings, diaphragms, center plates, cylinder test cocks, traction gears and other parts of diesel locomotives, and on several points of car trucks.

You may obtain (1) more facts on how Moly-Sulfide functions as an additive, and (2) sources of railroad greases containing Moly-Sulfide by using the coupon below.

*Names on request.



Department 38

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Chemical Composition of Lubricating Oils, Cutting Oils & Petroleum Solvents

W. C. Witham
Dept. of Chem. & Chem. Engrg.
Armour Research Foundation of
Illinois Inst. of Technology
Chicago 16, Illinois

In order to supply a background, we feel it desirable to summarize briefly the chemical constitution or composition of the materials involved; these products are cutting oils, lubricants, and solvents.

Cutting oils can be separated into two major classes: the straight oils, which are used neat or cut back with a solvent, and the soluble or emulsifiable cutting oils. The latter, when mixed with water, give oil-in-water emulsions in which water is the continuous phase.

STRAIGHT OILS

The straight cutting oils range from those containing no additives, to those containing large quantities of active ingredients. These oils can be classified as "inactive" and "active." These terms denote the ability of certain constituents in the oil to react with the work surface and, thus, to influence the cutting.

The inactive oils are usually mineral oils alone, or contain some fatty oils, fatty acids, or non-staining sulfurized fatty oils. The non-staining means that the sulfur added is chemically combined and will not react with copper under specified conditions.

The active oils usually contain either sulfur and/or chlorine, and sometimes phosphorus compounds. They can be classified chemically as sulfurized mineral oils, sulfurized mineral-fatty oils, sulfo-chlorinated mineral oils, and sulfo-chlorinated mineral-fatty oils. No attempt is being made to consider all of the possible ways in which sulfur or chlorine can be incorporated into a cutting oil. The patent literature on this subject is very large and very confusing.

The hydrocarbon portions of these oils are mixtures of alkylated aromatics and alkylated naphthenes. Some paraffin hydrocarbons are present, but most of the paraffinic structures occur in the alkyl groups. The aromatics are unsaturated cyclics; whereas the naphthenes are saturated cyclics, usually with a five-carbon ring as the base structure. There may be more than one ring in both types. The rings may be adjacent or condensed, that is, with shared atoms, and they may be mixed with aromatic and naphthenic rings in the same molecule.

The fatty oils referred to previously are the glycerol esters of organic acids such as stearic, palmitic, oleic, etc. When a fatty oil containing an oleic acid ester is sulfurized with a limited amount of sulfur, the sulfur reacts with the olefinic bonds, and the product is inactive or non-staining.

This paper was presented at the ASLE 10th Annual Meeting, Chicago, April 13, 1955.

However, when an excess of sulfur beyond that needed for the olefinic bonds is used, the product is an active base since it is staining to copper. Considerable uncertainty exists as to the form the excess sulfur has in the product; some is probably as disulfide, but much is probably just dissolved.

Chlorination, either of a mineral oil or a fatty oil, gives materials of unknown composition. This chlorine is characterized by ease of hydrolysis in the presence of water to give a very corrosive system. There are a number of proprietary sulfo-chloro bases which are fairly resistant to hydrolysis effects.

SOLUBLE OILS

The soluble oils contain emulsifiers which give an oil-in-water emulsion when the oil is added to water with agitation. There are a large number of materials which are used as emulsifiers. Typical examples are resin soaps, and petroleum sulfonates, alone or in combination; non-ionic emulsifiers also are used.

In addition, a coupling agent whose function is to stabilize the soap-oil system, and also to improve the emulsion, is commonly used. For example, butyl cellosolve is a well known coupling agent.

Many of the additives used in the straight oils are also found in the soluble oils. The adoption of these materials is somewhat tricky because of the method of use of soluble oils, that is, in an aqueous solution. A chloro-Compound, which is easily hydrolyzed, could give a very corrosive emulsion.

W. C. Witham

LUBRICATING OILS

In the case of lubricating oils, the preceding remarks on the constitution of mineral oils are again applicable. These oils often represent a higher degree of chemical refinement than the oils used in the cutting field, because of the greater stability required. However, there are many instances where one oil is used for lu-

bricating and cutting. When additives are used in these lubricating oils, they may include oxidation inhibitors, rust preventives, film strength agents, detergents, etc. Again, the variety of additives is so large as to be beyond the scope of this discussion. However, typical examples are metal salts of alkyl thiophosphoric acid as oxidation inhibitors, sulfonates as rust preventives, aryl phosphates as film strength agents, etc.

SOLVENTS

The solvents encountered in the metal working trades include straight petroleum spirits of varying degree of aromaticity and a number of special chlorinated solvents. The petroleum spirits are chemically similar to the lubricating oils but, being more volatile, have lower molecular weights and correspondingly simpler structures.

Book Reviews

"Bearing Design & Application," by D. F. Wilcock & E. R. Booser; McGraw-Hill Publishing Co., Inc., 327 W. 41st St., New York City, 1957; 470 pages, 225 illustrations, price $12.50.

This new book provides practical guidance to the machine designer in his selection and design of bearings and their lubrication for his machinery. It is likewise of value to workers in petroleum laboratories and lubricant companies, and to service personnel in metalworking and manufacturing industries.

Much of the material was provided by the authors' experience during the last 10 years on bearing designs for electrical apparatus, household appliances, instruments, and aircraft units. The Lubrication Division of ASME and the American Society of Lubrication Engineers contributed ideas.

The entire subject is considered from three aspects: (1) the design of the bearing, including its geometry, general configuration, and tolerances, (2) the materials from which the working parts of the bearing are made, and (3) the lubricant which serves to minimize the friction and wear in the bearing during its operation.

The material covers rolling element bearings, slider bearings (both journal and thrust), bearing materials, and troubleshooting.

"Contracts, Specifications & Engineering Relations" (Third Edition), original by D. W. Mead; rewritten by the Staff of Mead & Hunt, Inc. (H. W. Mead, Pres.), and J. R. Akerman, University of Wisconsin; McGraw-Hill Publishing Co., Inc., 330 W. 42nd St., New York City, 1956; 427 pages, price $7.00.

Widely used in colleges and universities for the past 40 years to set forth the important relations with which the engineer or architect should become familiar when starting his professional career, "Contracts, Specifications & Engineering Relations" has now been completely and carefully revised for present-day use. The basic discussion of ethics closely follows the treatment originated by D. W. Mead, the original author.

While the major emphasis is on law, contracts, and specifications, many other subjects are covered. Stress is placed on the use of good English, with special attention to the writing of technical reports and business letters. The specifications section is based on material currently used by architects and consulting engineers.

Coming Events

FEBRUARY 18-22, American Society of Civil Engineers (Convention), Jackson, Miss.

MARCH 11-15, Nuclear Congress, Convention Hall. Philadelphia, Pa.

18 & 19, Steel Founders' Society of America (55th Annual Meeting), Drake Hotel, Chicago, Ill.

25-27, American Society of Tool Engineers (25th Technical Meeting & Convention), Shamrock Hilton Hotel, Houston, Tex.

27-29, American Power Conference, Hotel Sherman, Chicago, Ill.

APRIL 8-12, American Welding Society (National Spring Meeting), Hotel Sheraton, Philadelphia, Pa.; April 9-11, Fifth Welding Show, Convention Hall, Phila.

9-11, The Canadian Institute of Mining & Metallurgy (Annual General Meeting), Quebec City, Quebec, Canada.

15-17, American Society of Lubrication Engineers (12th Annual Meeting & Exhibit), Sheraton-Cadillac Hotel, Detroit, Mich.

16-18, National Petroleum Association (Semi-annual Meeting), Hotel Cleveland, Cleveland, Ohio.

29 thru May 3, American Material Handling Society (7th national Materials Handling Exposition), Convention Hall, Philadelphia, Pa.

MAY 5-11, Second Cuban Petroleum Congress (Industry Exhibit, and Technical & Scientific Sessions), Havana.

14-16, Industrial Nuclear Technology Conference, Museum of Science & Industry, Chicago, Ill.

20-23, Design Engineering Show, Coliseum, New York City.

JUNE 3-7, American Society of Civil Engineers (Convention), Buffalo, N. Y.

11-13, Western Plant Maintenance & Engineering Show, Civic Auditorium, San Francisco, Calif.

SEPTEMBER 11-13, National Petroleum Association (Annual Meeting), Traymore Hotel, Atlantic City, N. J.

23 & 24, Steel Founders' Society of America (55th Fall Meeting), The Homestead Hotel, Hot Springs, Va.

OCTOBER 7-9, ASLE-ASME 4th Annual Lubrication Conference, Royal York Hotel, Toronto, Ont., Canada.

14-18, American Society of Civil Engineers (Convention), New York City.

NOVEMBER 11-13, Steel Founders' Society of America (12th Technical & Operating Conference), Carter Hotel, Cleveland, Ohio.

12-15, American Standards Association (8th National Conference on Standards, and 39th Annual Meeting), St. Francis Hotel, San Francisco, Calif.

The Lubrication of Friction Drives

Friction drives find frequent application where continuous variation in the speed-ratio of coupled shafts is required. In order to ensure high frictional forces between the power-transmitting elements, they are heavily loaded and lubricants giving a high coefficient of friction must preferably be used. An apparatus is described in which the frictional force between two rotating balls pressed together is measured in the region of speeds about the nominal rolling condition. The frictional behavior of the system is discussed, and it is shown that in the contact area there is relative sliding between the surfaces even when the balls are rolling together. This characteristic is a common feature of friction drives, and so the apparatus has been used to investigate the effect of lubricants on the coefficient of friction. The conclusion is reached that the temperature coefficient of viscosity of the lubricant used plays a large part in determining the efficiency of the friction drive, a large value being beneficial.

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Thornton Research Center
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INTRODUCTION

A great many variable-ratio couplings make use of the tractional force of friction between surfaces in nominal rolling contact to transmit power from one to the other. The principles of some well-known "frictional drives" are illustrated in Figure 1. It should be noted that in order to ensure a sufficiently high frictional force, the load between the contacting surfaces must be high. This is brought about in different ways in the various types. It is necessary to lubricate these systems in order to assist in heat dissipation and to prevent seizure and wear of the contacting surfaces, but at the same time the coefficient of friction must be kept as high as possible. Thus, the rather unusual feature of lubrication with high friction is required. An apparatus which incorporates two rotating balls in contact as in a friction drive has, therefore, been used to investigate the frictional characteristics of oils.

EXPERIMENTAL

The apparatus used was the two-ball machine. A description of the general arrangement of this machine has been given elsewhere,[1] but it has been modified since the earlier account was given to enable the frictional forces between the balls to be measured. The principle of the modified machine is shown in Figure 2.

The upper-ball assembly is fitted with a horizontal hinge on which it can be swung back to disengage the balls. The block carrying this hinge is free to rotate about a vertical axis (AB in Figure 2). During rotation of the balls, the frictional force tends to turn the upper-ball assembly about the axis AB, and the resulting torque can be measured with the spring balance which is adjusted until the torque arm extending from the hinge block is just disengaged from the restraining stop. If the vertical axes of the balls do not lie in the same plane as AB, there is a tendency for the upper ball and its assembly to slide, either to the right or to the left, across the lower ball. It is difficult to ensure this alignment of the axes, and for this reason when frictional measurements are being made, the balls are rotated first in one direction and then in the other. In this way the frictional force F is reversed in direction

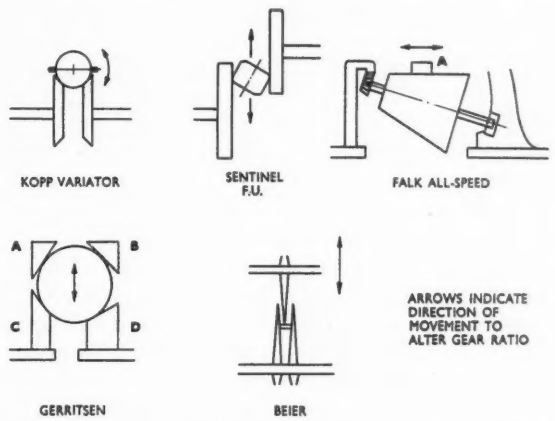

Figure 1. Principles of some variable-speed drives. High loads between friction elements are mostly obtained by means of springs; for the Falk, the centrifugal force acting on the cone loads it against the band A. In the Gerritsen, A & B do not rotate but can move axially; springs force A to D and B to C.

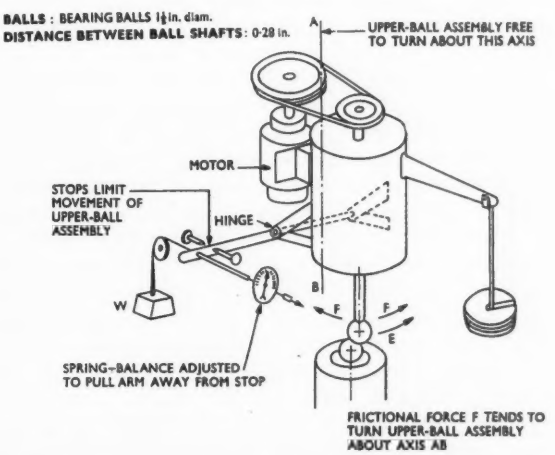

Figure 2. Diagrammatic sketch of Two-Ball Machine modified to measure friction.

Presented under the sponsorship of the American Society of Lubrication Engineers before the Second Annual ASLE-ASME Lubrication Conference, Indianapolis, Indiana, October 10-12, 1955.

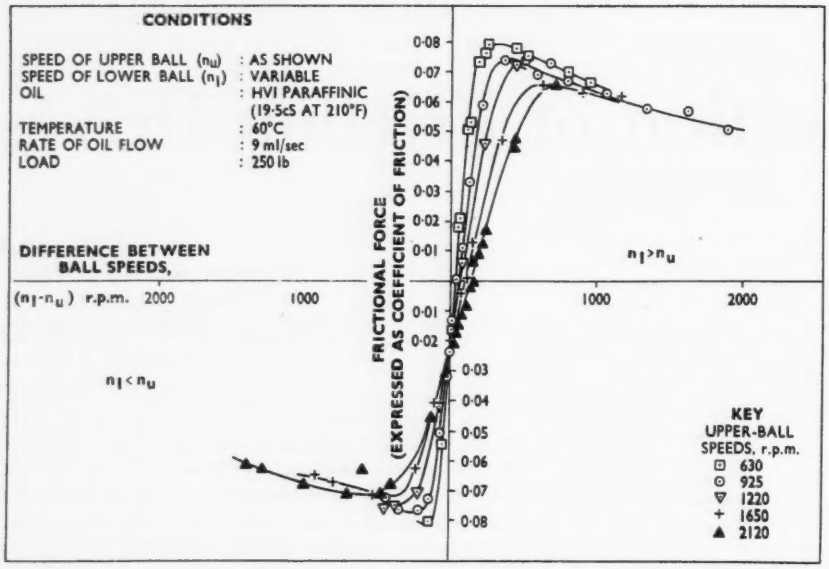

Figure 3. Two-Ball Machine: variation of frictional force with sliding speed.

but any additional force due to misalignment is unaffected. If E in Figure 2 represents the force due to errors of alignment in the apparatus — supposed in the direction shown, then the resultant torque on the upper-ball assembly which is balanced by adjusting the pull S on the spring-balance, is, for the two directions of rotation of the balls:

$$(F+E)r_1 = (W-S_1)r_2 \qquad (1)$$

and

$$(F-E)r_1 = (S_2-W)r_2 \qquad (2)$$

where r_1 and r_2 are the effective distances of the two sets of forces from the axis of rotation AB, and W is the counterweight on the spring balance, whence

$$2F = (S_2-S_1)\frac{r_2}{r_1} \qquad (3)$$

and the error is eliminated. Other possible sources of error, such as a zero error in the spring balance or friction in the pivot, are also cancelled out. Lubrication of the test balls in the early experiments was by a jet of oil, but later was carried out by means of felt pads soaked with test oil, lightly pressing on the path of contact. Separate pads were used for each test oil.

The initial experiments were designed to investigate the behavior of the coefficient of friction in the region where the speeds of the shafts carrying the balls were equal; i.e., when the balls were rolling each on the other.

The speed of the upper ball of the two-ball machine is not continuously variable but may be altered by a change of pulleys, whereas the lower ball is driven by a d-c motor with speed control. The upper ball shaft speed was, therefore, kept constant and the speed of the lower shaft varied from a value less than, to one greater than, that of the upper. The test conditions and results are given in Figure 3. The oil used was a solvent refined paraffinic oil of viscosity 19.5 cs at 210° F. and KVI of 96.

The curves show that when the spindle speeds are equal (sliding velocity zero), the coefficient of friction is the same for all curves. Under these conditions the balls may be regarded as rolling together, but the magnitude of the coefficient of friction (0.02) is high compared with coefficients of rolling friction (10^{-3}) usually associated with this condition — as in ball bearings for example. As the sliding speed increases, the coefficient of friction also increases at first, until a maximum is reached, and thereafter falls.

A study of the surface motions of the balls within the contact will assist in explaining some of these phenomena. Under a load of 250 lb., the radius of the contact area as calculated from the appropriate Hertz formula will be 0.0164 in. Contact thus takes place over an appreciable area, and for a given spindle speed there will be a variation in surface speed from the inside to the outside of the contact area. A projection of the paths of contact on to a horizontal plane, shown in Figure 4, makes this clearer, and it will also be seen that sliding within the contact is not uniform. When the shaft speeds are equal, the surface speeds of the balls will be equal only along the horizontal diameter of the contact area, and there will be sliding in opposite directions in the two halves of the contact. As the rotational speed of one of the shafts increases, the position of equal surface speed gradually moves to the inner edge of the path of contact of the faster ball. When this position is reached, the sliding in the contact is all in one direction.

Expressed mathematically, this conditions occurs when

$$(r+\delta\cos\theta)n_l = (r-\delta\cos\theta)n_u \qquad (4)$$

or

$$(r-\delta\cos\theta)\,n_l = (r+\delta\cos\theta)n_u \qquad (5)$$

or, expressed more conveniently, when

$$\frac{\text{rotational speed of the faster ball}}{\text{rotational speed of the slower ball}} = \frac{r+\delta\cos\theta}{r-\delta\cos\theta} \qquad (6)$$

The value of r is 0.140 in., and of θ is approximately 9 deg.

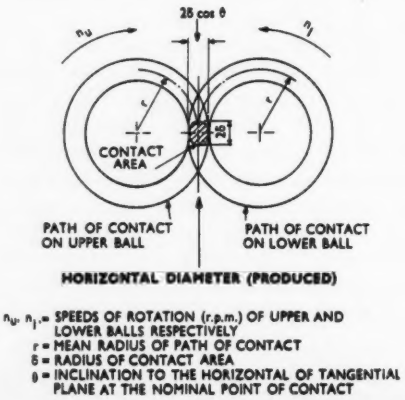
2δ cos θ
n_u
n_l
CONTACT AREA
2δ
PATH OF CONTACT ON UPPER BALL
PATH OF CONTACT ON LOWER BALL
HORIZONTAL DIAMETER (PRODUCED)
n_u, n_l = SPEEDS OF ROTATION (r.p.m.) OF UPPER AND LOWER BALLS RESPECTIVELY
r = MEAN RADIUS OF PATH OF CONTACT
δ = RADIUS OF CONTACT AREA
θ = INCLINATION TO THE HORIZONTAL OF TANGENTIAL PLANE AT THE NOMINAL POINT OF CONTACT

Figure 4. Two-Ball Machine: horizontal projection of paths of contact.

Table I
Two-Ball Machine
Ratio of ball speeds (faster/slower) at which the maximum value of the coefficient of friction was observed

Upper-ball speed, rpm	Sliding speed at which maximum friction occurred (lower-upper) rpm	Ratio: n_{faster}/n_{slower}
630	280	1.44
925	440	1.48
925	–240	1.35
1220	–400	1.49
1650	700	1.42
1650	–520	1.46
2120	–600	1.40

For a load of 250 lb., $\delta = 0.0164$ in., whence this ratio is given by $156/124 = 1.26$.

Corresponding to this difference in the directions of sliding, there will be a difference in the directions of the frictional forces. The observed frictional force, which is the resultant of these two opposed forces, may, therefore, be expected to increase as the speed of one shaft becomes greater than that of the other until finally, when the sliding and frictional forces are wholly in the same direction, the whole of the frictional force will be measured. As the speed of one shaft gradually exceeds that of the other, changes in the coefficient of friction with speed are, in the early stages, due to what might be called the "differential sliding effect" just described, as well as to any change due solely to the magnitude of the sliding speed itself. When the speed of one shaft is so much greater than the speed of the other that the differential effect is no longer present, then any subsequent changes in friction must be due to the effect of sliding speed only. At this stage, a change in the slope of the friction/speed curve would be expected, and possibly the maximum exhibited by each curve in Figure 3 corresponds to this point.

The values of n_{faster}/n_{slower} at which the maximum values of coefficient of friction were observed are listed in Table I. They show good agreement among themselves, but have a mean value which is slightly higher than the value of 1.26 for the ratio of ball speeds at which the differential sliding effect vanishes. However, the agreement is close enough to suggest that the reason for the occurrence of the maxima is as indicated.

When the spindle speeds are equal, there is some sliding in the contact, as already explained, so that conditions are not the same as in a pure rolling contact. It is, therefore, not surprising that the coefficient of friction measured under these conditions is different from coefficients of friction usually associated with rolling. Even so, the origin of the large frictional force is obscure. It may be that although the sliding conditions in the two halves of the

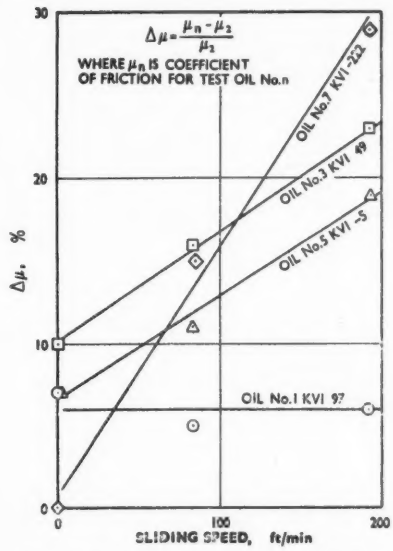

Figure 5. Two-Ball Machine: increase in coefficient of friction (relative to Oil No. 2) with sliding speed.

contact are equal and opposite, the load is not evenly divided between these two semi-circular areas since it is applied not quite normally to the surface. Hence, a resultant frictional force remains. There may be some connection between this finding and a similar phenomenon described by Gerritsen[2] with reference to a gear[3] incorporating a friction drive between balls and cones in which the transmission of power was found to alter the position of the "center of contact" between the ball and the cone.

Examination of systems shown in Figure 1 will show that sliding will take place in the contact area in an analogous manner to that discussed for the two-ball machine.

If the above analysis of the motion of the ball surfaces is correct, then there is no particular virtue in measuring friction under "pure-rolling" conditions, since this merely leads to a loss of sensitivity in the measurements. In these circumstances the resultant frictional force is, as pointed out above, the difference between the two forces of sliding friction, each comparatively large and capable of being measured more accurately and easily than their difference. The choice of "pure-rolling" conditions is also bad for experimental reasons, since in this region friction varies with speed much more rapidly than elsewhere, as will be seen from Figure 3. Consequently the difficulty in controlling the speed of the two-ball machine very precisely will give rise to a disproportionate amount of scatter among the test results. Therefore, most of the further experimental work was done under sliding conditions.

Table II
Properties of Oils

Test Oil No.	Description	Kinematic Viscosity cs at 100° F.	Kinematic Viscosity cs at 210° F.	K.V.I.	ASTM Viscosity Slope Factor
1	Solvent refined paraffinic	33.9	5.32	97	261
2	Solvent refined paraffinic	151.7	13.98	96	238
3	Solvent refined naphthenic	14.9	3.05	49	283
4	Solvent refined naphthenic	141.5	10.57	46	271
5	Acid refined naphthenic	21.3	3.48	–5	295
6	Acid refined naphthenic	115.5	8.54	14	290
7	Alkylated naphthalenes	98.5	5.70	–222	346

Table III
Variation of Coefficient of Friction
with Sliding Speed of the Two-Ball Machine

Test Oil No.	Coefficient of friction, $\mu \times 10^3$ (mean of four results) for sliding speed of: 0 fpm	83 fpm	192 fpm
1	32	64	51
2	30	61	48
3	33	71	59
4	32	68	55
5	32	68	57
6	33	68	56
7	30	70	62

Test Conditions: Balls, R & M, steel, 1½ in. diam.; Oil temperature, 20° C.; Rate of oil flow, zero;

Upper ball speed	520	2140	3190	rpm
Lower ball speed	520	1000	570	rpm
Sliding speed	0	83	192	ft./min.
Load	118	110	98	lb.

The oils used and their properties are listed in Table II. ASTM viscosity slope factors calculated according to Hirschler[4] are given in addition to K.V.I., since the latter quantity is of doubtful meaning for oils whose viscosity is less than 8 cs at 210°F.

TEST RESULTS

The test results and test conditions are presented in Table III. It will be noted that the loads vary slightly in the different experiments. This was caused by the necessity to move the upper-ball driving motor to accommodate suitable driving belts when changing the pulley ratio. Although other work on the two-ball machine had shown that coefficients of friction fell as the load was raised, variation over the load range used in the current experiment has negligible effect.

It will be seen that the difference between the frictional coefficients of oils increases with sliding speed. The changes in general level of the results at different speeds are due to the peculiarities of the system and are explained by reference to the curves of Figure 3. For ease of comparison, some of the results are shown plotted in Figure 5 in terms of those for test oil No. 2 (which were the lowest at all three sliding speeds).

These results show that the effect of viscosity grade for a given type of lubricant is small. Bigger differences are noted as the type of oil is changed; under given conditions, the lower the K.V.I. (or greater the ASTM slope) the higher, generally, the frictional force. Moreover, friction falls off less with increasing speed (in the range of high speeds) for oils of low K.V.I. This suggests that the temperature in the contact plays an important part in determining the coefficient of friction.

As the temperature rises, the viscosity of the oils with the lowest K.V.I. will decrease most and, if we suppose that lubrication is of the thin-film type where both boundary lubrication and hydro-dynamic effects are playing a part, an explanation of the observed effects is provided, since a rise in temperature will tend to reduce the magnitude of the hydrodynamic effects.

As long as the friction elements in a friction drive are nominally rolling together, differential sliding speeds will be low. Even so, they can reach appreciable magnitudes. For an example, a sliding speed of 50 fpm has been quoted as typical of the magnitude of the "creep" in the Gerritsen Gear (loc. cit.) and, therefore, the results obtained under the appreciable sliding of the present experiments would seem to be appropriate, even if these sliding conditions had not been chosen for the purpose of accentuating the differences between oils.

For the hydrocarbon materials investigated, it thus appears that viscosity index reflects the performance characteristics of the oils; the lower the K.V.I. the better. Whether this is due entirely to a reduction in viscosity with increasing temperature as the speed increases or to a change in other properties of the fluid, is a question which must remain unanswered until the factors affecting lubrication in the "thin-film" region are elucidated.

If there is any tendency for gross slip to take place between the elements of the friction drive, then again an oil with a low viscosity index would appear to offer the best corrective. Since it may also be important to keep churning losses low, an oil of low viscosity would be advisable; a low viscosity oil would also be advantageous from the friction point of view.

The chemical properties of the oils have not been discussed in this paper, but in selecting an oil for a friction drive it is important to choose an oil with good oxidation stability and other appropriate properties.

BIBLIOGRAPHY

1. Lane, T. B., "Scuffing Temperatures of Boundary Lubricant Films," *British Journal of Applied Physics, Supplement No. 1*, 1951, p. 35.
2. Gerritsen, J. J., "The Gerritsen Infinitely Variable Gear," *Engineering, Vol. 171*, 1951, p. 350.
3. Gerritsen, J. J., "The Gerritsen Infinitely Variable Gear," *Engineering, Vol. 170*, 1950, p. 530.
4. Hirschler, A. E., "Molecular Weights of Viscous Hydrocarbon Oils: Correlation of Density with Viscosities," *Journal of the Institute of Petroleum, Vol. 32*, 1946, p. 133.

ACKNOWLEDGEMENTS. The author wishes to express his thanks to the Directors of "Shell" Research Ltd. for permission to publish this paper.

It's Detroit in '57

as the scene of the

ASLE 12th Annual Meeting & Exhibit

April 15-16-17 Sheraton-Cadillac Hotel

Skin Diseases Caused by Cutting Oils

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University of Illinois
School of Medicine
Chicago, Illinois

When cutting oils contact the skin of a worker, they may cause various diseases of the skin. The common ones are oil acne (blackheads), dermatitis, and infected wounds. Other diseases occurring occasionally are granuloma, melanoderma, chloracne, and cancer. During and since World War II, "oil rashes" are common gossip among oil workers, partly through advertisements in newspapers and signs on highways. Employers and workers are concerned about their medical problems, and many come to physicians for information.

OIL BLACKHEADS (PETROLEUM ACNE)

Lathe and drill press operators, tool makers, and other workers exposed to oils in various daily operations seldom escape the formation of oil blackheads in their skin. These "black dots" or "oil plugs" usually appear first on the dorsum of the fingers and the extensor surface of the forearms (hairy area). Later, the thighs and face are involved with "black dots". Oil is rubbed into the skin of the forearms, and the friction of oil-soaked trousers causes oil to penetrate the skin of the thighs.

Oil blackheads are simply broken hairs and horny cells mixed with oil and dirt. The blackheads are seated in the openings of the skin, particularly the hair follicles. As a rule, the hairless skin has fewer oil blackheads than the hairy one. Also, the worker concerned with cleanliness of his skin and work clothes has fewer "black dots" than the worker not concerned about his appearance.

What happens to the oil blackheads in the human skin? They disappear within a few weeks if the worker avoids oil in a different occupation. If he does not change his job, more oil blackheads form. Eventually, infection of one or more of the blackheads occurs. Usually the infection involves the forearms first, and the thighs later. The infection of the hair follicles is known as "folliculitis". Other infections of less frequent occurrence are abscesses and carbuncles. There is some misunderstanding among both laity and physicians as to the source of this infection.

The United States Public Health Service has analyzed insoluble cutting oils and found no significant number of bacteria in them. Cutting oils are unfavorable for the growth of bacteria, because they contain substances prohibitive to such growth. Rather, the infections are caused by bacteria already present on the skin of the worker. Once the skin is studded with many blackheads, then it is not difficult for infections to begin in these foreign bodies.

DERMATITIS

Dermatitis caused by insoluble and soluble oils is fairly common in machinists and mechanics. The inflammation begins on the hands and forearms because of maximum exposure of these parts to oil. Occasionally, if the worker's clothes become saturated with oil, the disease is generalized. The objective signs of oil dermatitis are no different than from dermatitis caused by other external substances. It has been my experience that dermatitis of the hands and forearms caused by soluble oils is more common than years ago. This inflammation is caused by the oil itself, the inhibitor, rancidity of the oil, or the presence of bacterio-static agents in the oil.

Metal slivers in oil and in cloths for the drying of the hands damage the skin, and these small wounds may become infected. Thus, boils and lymphangitis occur in some instances following a minor injury caused by a metal sliver.

DEFATTING ACTION

It is a frequent experience that dryness of the worker's skin is caused by petroleum oils. Those exposed to oils constantly during their work suffer more than occasional workers. The defatting action of oils is less on a greasy skin with active sebaceous glands than on a dry one. Unless the defatting action of oils is interrupted by a change of occupation, then the skin becomes more dry and eventually cracks. These cracks, or fissures, may become infected. The types of infection are similar to those enumerated under "Oil Blackheads". The secondary infections occurring on a dry skin and in association with oil blackheads may lead to boils, lymphangitis, and sometimes septicemia.

GRANULOMAS

If oils plug the follicles, two types of granulomas may occur on the skin. The most common one is match head sized, yellowish, raised, solid nodules appearing on the forearms. Usually the granulomas are multiple, and may have a linear arrangement at times. A central blackhead is present in some of the lesions.

The less frequent granuloma is single and about one centimeter in diameter. This

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This paper was presented at the ASLE 10th Annual Meeting, Chicago, April 13, 1955.

nodule is not fixed to the deeper structures. There is a central depression in the nodule, which is darkened in appearance.

Brown or black keratoses may occur on the dorsum of the hands and fingers following exposure to oils from shale oil or tar. Often the worker is unaware of these horny growths, since they are not troublesome. It should be mentioned that, recently, keratoacanthoma has occurred in several workers exposed to oil.

MELANODERMA

Melanoderma is pigmentation of the skin caused by various chronic irritations from various external sources aside from oils. Melanoderma is of considerable concern to the worker when it occurs, but this occurrence is seldom. The change in the color of the skin of the worker is gradual, on the forearms, neck, and face. It is not until the face has a peculiar hue that patients consult the physician. The worker with a dark skin, as in the Mediterranean races, is affected oftener with melanoderma than those with a light-colored skin. The color of the affected skin is dark brown to tan and is seldom uniform throughout the affected sites. Generally the skin becomes slightly thickened, the follicles or openings in the skin are prominent; but the degree of plugging is less than in the usual blackhead formation. Plugged follicles are few in hyperpigmented sites, and their absence does not speak against the diagnosis of melanoderma. When melanoderma occurs, it is difficult to convince both the employer and the worker that the disfigurement of the skin is a temporary one. The duration of the discoloration of the skin may continue for at least six months, even though chronic irritation is avoided. For the sake of emphasis, it is worth repeating that hyperpigmentation of the skin caused by external factors such as oil and pitch is not permanent, provided the extrinsic factor is discontinued.

CHLORACNE

Chloracne is caused by exposure to certain chlorinated hydrocarbons, and it is not uncommon in those who handle insoluble cutting oils containing such compounds. This form of cutting oil is used for heavy duty work and, while the machine is in use, vapors and mists are generated and tend to contact the exposed parts of the skin and, occasionally, impregnate clothing of the worker. Occasionally, the inhalations of such mists and vapors in sufficient amounts may cause liver damage and other systemic effects. Straw-colored cysts are more numerous than blackheads in chloracne. The cysts appear on the sides of the neck and are a prominent feature of this disease.

CANCER

Cancers of the skin caused by oils are usually of the prickle cell type. Frequently these cancers are multiple, and usually occur on the parts exposed to the oils. The most frequent location of these cancers is on the hands, arms, neck, and scrotum. There is considerable doubt among some authorities whether or not oils may cause cancer.

Lubrication in the News

Diethylene Triamine: Valuable Intermediate for Lubricating Oil Additives. Higher horsepower through increased compression ratios in today's automobile engine has created a strong demand for oil additives. Oil additives are required since more horsepower is being achieved with only a slight increase in engine size.

Higher octane gasoline, gained through a boost in tetraethyl lead and higher aromatics, is needed to obtain the desired power. But after fuel combustion, there is an increase in residues and varnish polymers. Higher temperatures also result. Oil additives come into the spotlight now, because they are useful in removing and suspending residues and in stabilizing the oil against degradation by excessive heat.

Various polyethylene amines are used as intermediates for lube oil additives. One valuable intermediate is diethylene triamine (DETA) which possesses two primary and one secondary amine groupings. These amino structures make DETA valuable in producing amine salts, amides, and imidazolines (glyoxalidines) which can be adapted as additives of the following types:

(1) Anti-oxidants such as imidazolines made through the reaction of diethylene triamine and fatty acids. These additives reduce breakdown of oil to sludge.

(2) Detergent products formed through the condensation of alcohols and DETA. Detergents suspend carbon particles, varnishes, and sludges resulting from gasoline combustion and oil degradation.

(3) Corrosion inhibitors, such as diethylene triamine alone, protect the metal in automobile engines from sulfur-containing acids and other acidic components.

(4) Imidazolines used in filter cartridges are valuable in protecting motors against water and sludge.

(5) Useful acrylamide derivatives of the ethylene amines include pour point depressants

(Continued on p. 101)

Section News

CHICAGO, January meeting. E. J. Colerick, Staff Engineer specializing in rust preventives and textile oils for the Shell Oil Co., presented a paper entitled "Rust Preventives." (Submitted by E. W. Drummond, Sec'y-Treas.)

INDIANAPOLIS, October '56. Panel Discussion on "Organization of a Preventive Maintenance Program & Its Problems as Related to Lubrication."

November. Plant Tour of the U. S. Rubber Co., Indianapolis, Ind. (Submitted by G. H. Pearson, Jr., Sec'y-Treas.)

Studies of Formation & Behavior of an Extreme-Pressure Film

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Gears lubricated with a mineral oil compounded with dibenzyl disulfide containing radioactive sulfur, S^{35}, were operated under controlled conditions. The formation and behavior of the resultant sulfur-containing film on the load-bearing surfaces were studied, using the β-particles from the sulfur as the means of detection of the film and measurement of its thickness.

The thickness of the extreme-pressure film increased with load, but was not affected by duration of running, which suggests that an appropriate steady-state thickness of E.P. film was established for each operating condition. With respect to the tooth operating profile, the minimum thickness of E.P. film occurred at the pitch circle, and it gradually increased toward the addendum and the dedendum. These observations suggest that the temperature existing under the actual gear contact is controlling in the formation of an extreme-pressure film. The maximum thickness of the film observed in this series of experiments was approximately 1.2×10^{-6} inch, which is smaller than the average height of projecting asperities of a surface finished to 20 micro inches.

INTRODUCTION

The unique property of certain elements, such as sulfur, chlorine, and phosphorus, to arrest scoring of metals and thereby substantially increase the load-carrying capacity of oils, was noted in the early 1920's. Since that time a great number of so-called extreme-pressure agents have been developed, and their role as additives to lubricating and cutting oils has become important. Many explanations for the mechanism of action of the extreme-pressure agents have been offered. Perhaps the most widely accepted one[1, 2] holds that the extreme-pressure agents form protective films on the rubbing surfaces. These films are products of reaction between the extreme-pressure agent and the metal. Thus, with steel rubbing surfaces, all extreme-pressure agents based on sulfur form iron sulfide films; those based on chlorine form iron chloride, and those containing phosphorus react to form iron phosphide (or phosphate) films. The existence of such films has been verified by various chemical analyses and by x-ray and electron diffraction patterns, but the mechanism of formation of extreme-pressure films right on the rubbing surfaces of machine elements, and their thickness and action in preventing scoring, have been little known and understood. Many attempts have been made to study the mechanism of formation and action of these films. Prutton and Turnbull,[3] and Beeck, Givens and Williams,[4] for example, studied the mechanism of action of organic phosphorus, chlorine, and sulfur compounds in extreme-pressure lubrication, but the data are incomplete. At present, with the development of the radioactive tracer technique and the availability of radioactive isotopes, great possibilities are offered for expanding our knowledge of the mechanism of formation and action of extreme-pressure films. First attempt to utilize a radioactive isotope of sulfur, S^{35}, for this purpose was made in 1943 by Clark, Gallo and Lincoln.[5] Their experiments, however, were made in the

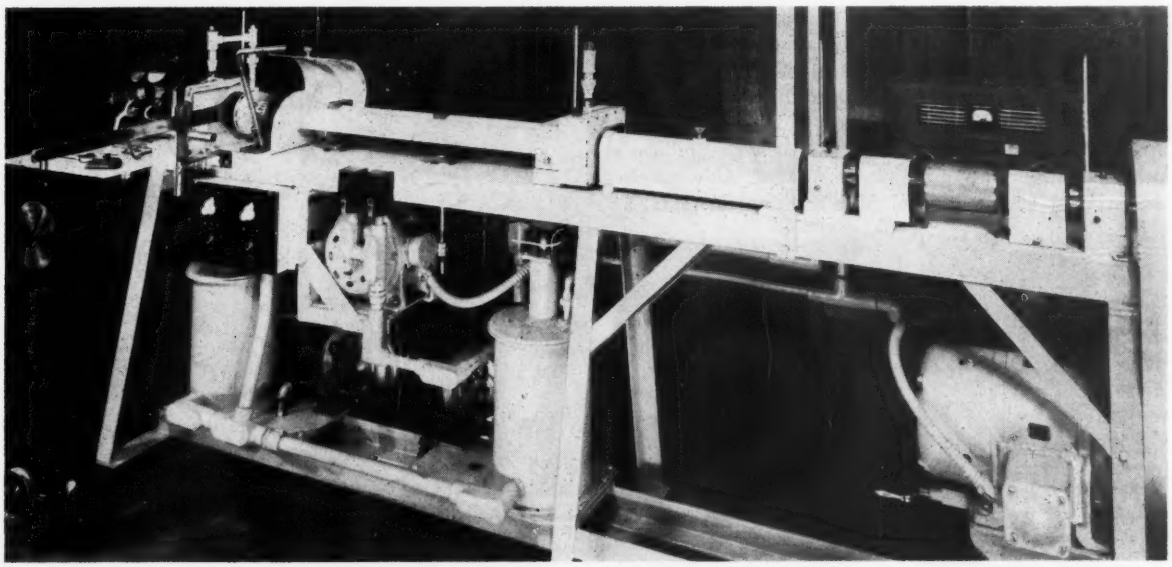

Figure 1. Side view of gear lubricants testing machine.

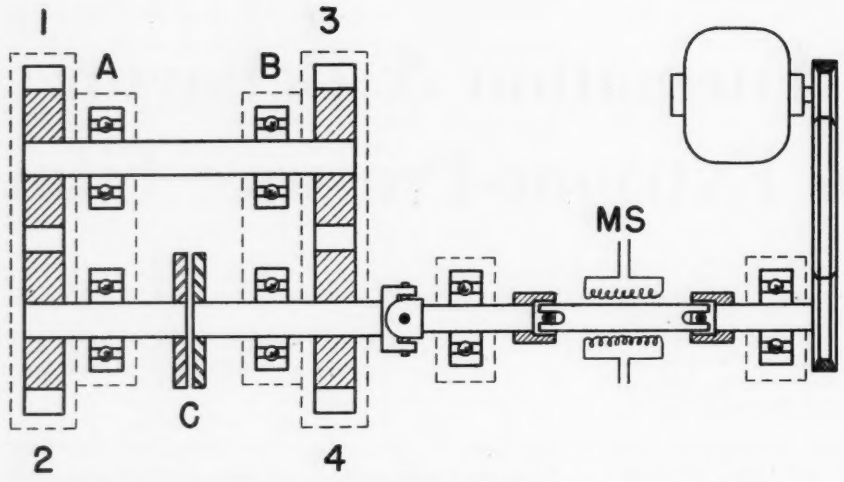

Figure 2. Schematic diagram of spur gear machine. Key: 1 & 2, test gears; 3 & 4 idler gears (for completing 4-square circuit); A & B, shaft bearings; C, split coupling (for loading); MS, torque meter.

"test tube" and, although they produced some valuable information, they added little to the explanation of the action of extreme-pressure agents on actual rubbing surfaces. Since in our studies of gear lubrication the problem of extreme-pressure is of paramount importance, it was decided to utilize the radioactive tracer technique for this study.

In the experiments described below, an extreme-pressure compounded lubricant was prepared using dibenzyl disulfide containing radioactive sulfur, S^{35}. Gears were operated under controlled conditions with this lubricant. After operating the gears under a particular set of conditions, they were washed and examined for radioactivity by both count and autoradiograph methods. Suitable calibrations enabled conclusions to be drawn as to the extent and distribution of the sulfide deposition.

EXPERIMENTAL

Preparation of Radioactive Lubricant

Dibenzyl disulfide-S^{35} was obtained from Isotope Specialties Company. It had been recrystallized twice from ethanol, and had a melting point of 68-69° C. The recrystallization was specifically designed to remove any trace of mercaptan, which is quite alcohol-soluble. The specific activity of the compound was approximately one millicurie per millimole. This material was diluted with inactive dibenzyl disulfide* and dissolved in SAE 30 mineral oil by gentle warming and swirling. The amounts used were selected to give an oil containing 0.5 wt. % sulfur.

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C. D. Wagner

Apparatus and Test Conditions

The tests were conducted in a spur gear machine, based on the well-known closed power circuit or four-square principle. Figure 1 shows this machine, and a diagrammatic sketch is given in Figure 2.

The gears were 17- and 19-tooth involute spur gears of 6 diametral pitch, 20° pressure angle and 0.25 inch face width. These gears were made of an equivalent of SAE 3312 steel, case hardened to 62Rc and finished to 20 microinches. They were operated at 3000 rpm, with lubricant flow-rate of 10 ml. per second and load increments of five pounds on the scale, corresponding to a contact load of 360 pounds per inch. The running time at each load setting was 30 minutes, 1 hour and 3 hours.

Measurement of Radioactivity on Gear Surfaces

After the run at each load, the gears were removed by special instruments and washed with a hydrocarbon solvent. Washing was done by dipping successively three times each in three separate containers of 300 ml. of hydrocarbon solvent. By special experiments it was established that

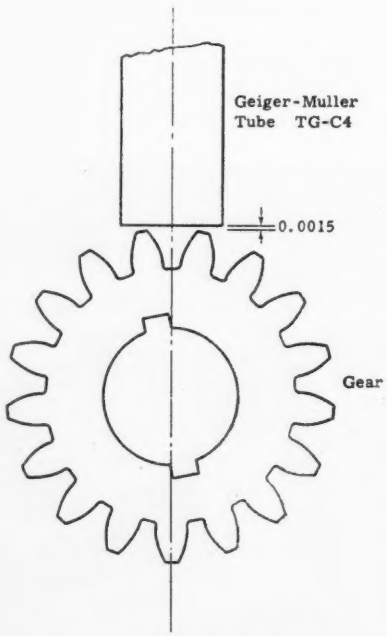

Figure 3. Position of counting tube with respect to gear for measurements of radioactivity.

*Bios Laboratories product.

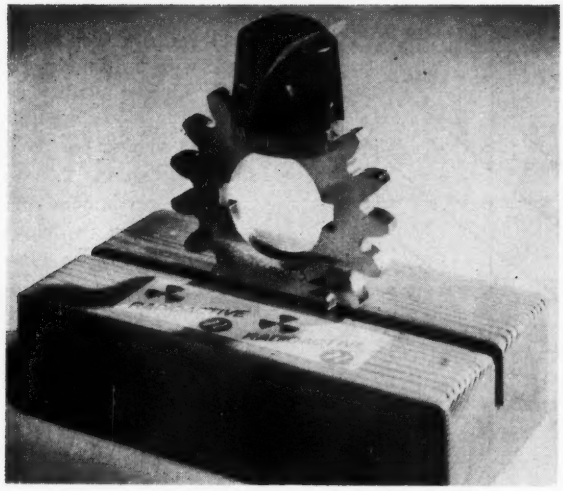

Figure 4. Holders used for autoradiographing gear tooth surfaces.

such washing removed approximately two per cent of the film formed. The dried gears were then examined for radioactivity.

A general idea of activity on the tooth working surface was gained by the counting rate recorded with a thin window G-M counter placed in the position shown in Figure 3. Recorded data are based on averages of five readings for each gear.

Specific data on idle and working surfaces were obtained by using aluminum shields formed to fit one tooth and covering the other exposed surfaces. The aluminum was of sufficient thickness to absorb all incident β-particles. Sides of the teeth were examined in the obvious manner, with the counter window 0.0015 inch from the gear.

Distribution of activity on the gear tooth working surface was studied by making autoradiographs, using Eastman Industrial Type K films. A special plastic holder, shown in Figure 4, was employed to expose the film in a position close to the surface, with shielding from neighboring surfaces. Exposure time was 16 hours.

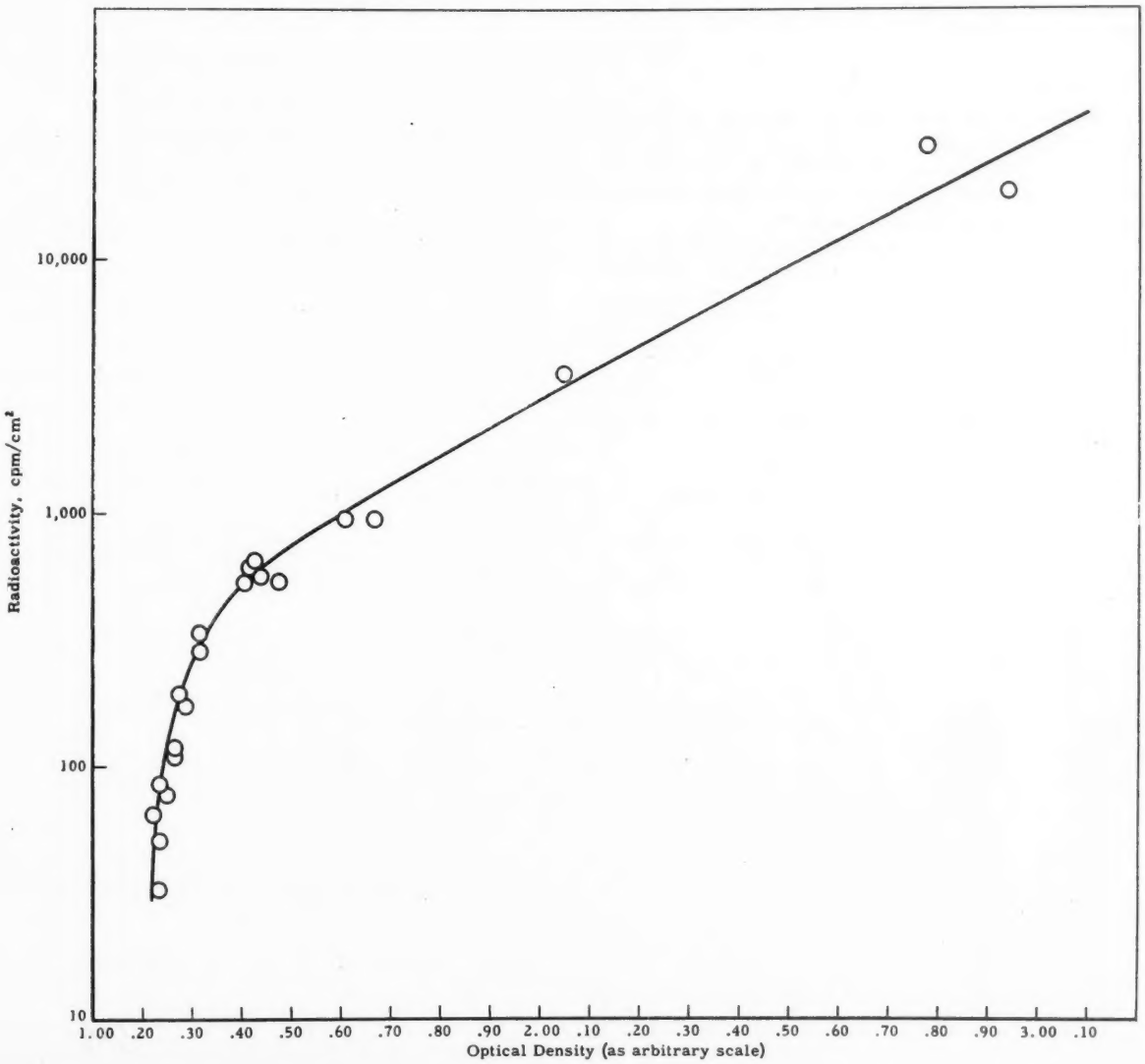

Figure 5. Radioactivity vs. optical density.

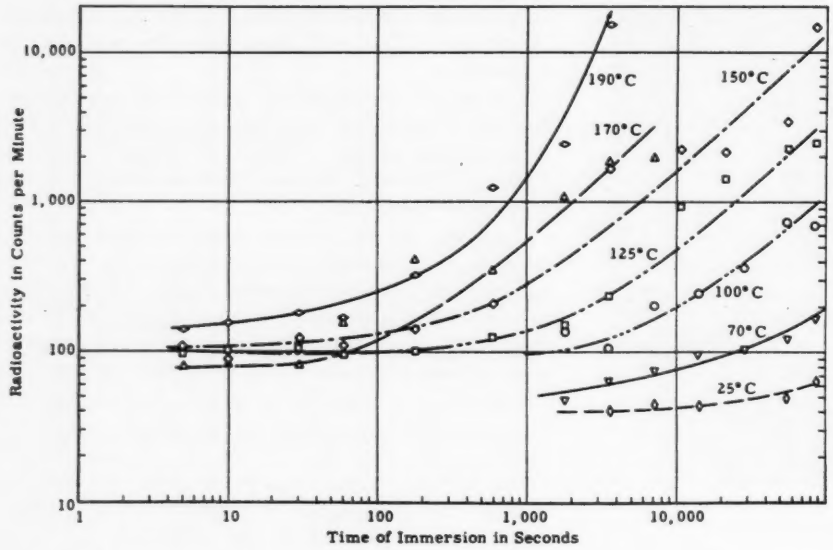

Figure 6. Radioactivity of iron-sulfide film formed on steel strips vs. time at different temperatures of immersion.

window of G-M counter. The strips were then autoradiographed with a 16-hours exposure. Optical density of the film was plotted against counts per minute per cm.^{2}, as shown in Figure 5.

Counts per minute per cm.^{2} were related to counts per minute per mg. of sulfur by counting an area containing a known amount of the radioactive sulfur. This was done readily by using a n-pentane solution of the radioactive oil. By this means, a film of 3 mg. of oil on a 4.5 cm.^{2} planchet was prepared. The recorded counting rate at the particular time this study was made was 2480 cpm for 0.028 mg. of sulfur on the planchet. This standardization and a decay correction permitted direct conversion of optical density to mg. of sulfur per cm^2.

Conversion of mg.S/cm.^{2} to monolayers or to microinches depends upon an assumption as to volume ocupied by the sulfur. Assuming an effective density of 2.0, the

CALIBRATION

Because of the geometrical arrangement, meaningful absolute data are difficult to obtain by direct counting. For this purpose, the optical densities of the autoradiographs were measured.† These optical densities were converted to absolute thickness as follows:

Steel strips that had been exposed to the radioactive oil were counted, with the strip 0.0015 inch from the

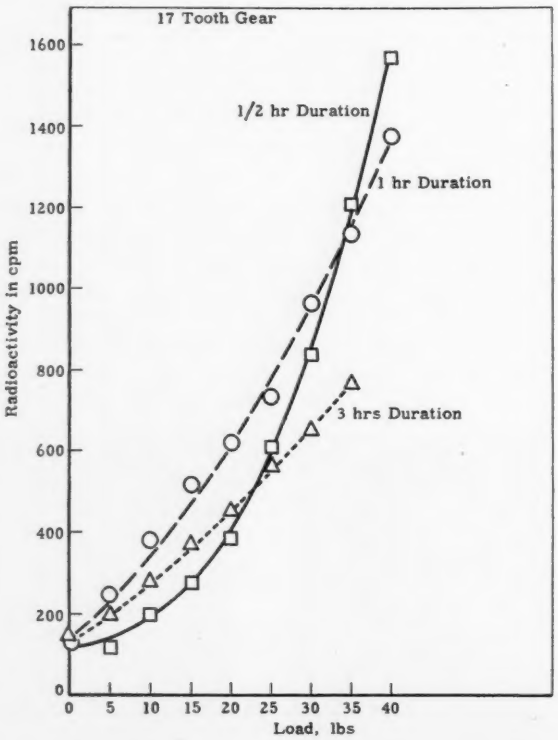

Figure 7. Radioactivity of gear teeth monitored without shielding.

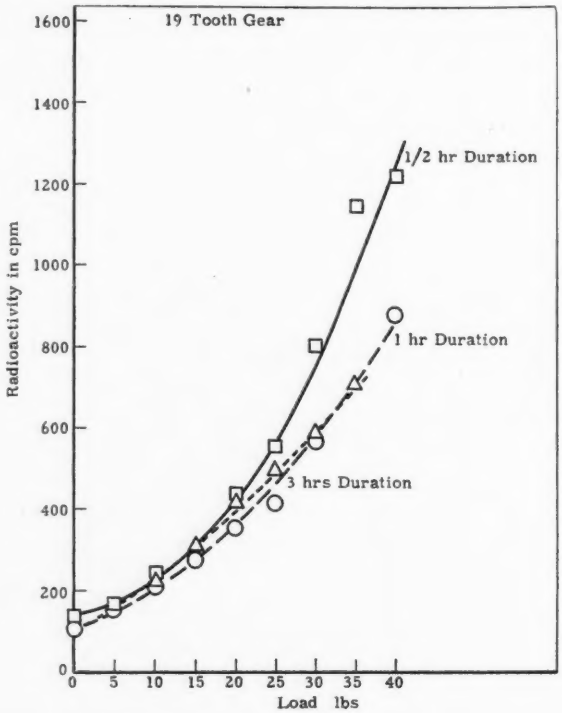

Figure 8. Radioactivity of gear teeth monitored without shielding.

†A Photovolt Electronic Transmission Densitometer, manufactured by Photovolt Corporation of New York, was used. Areas of films of one mm^2 each were examined.

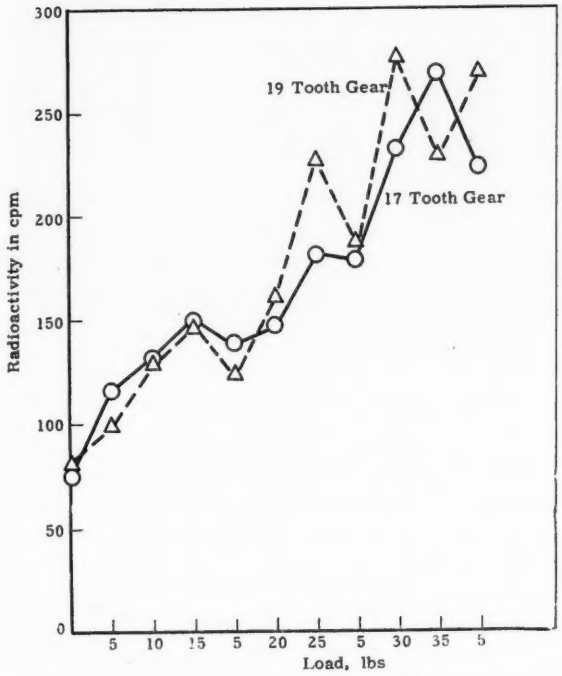

Figure 9. Radioactivity on working surface of gear teeth.

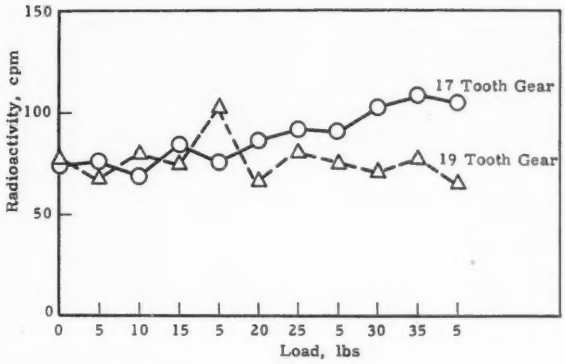

Figure 10. Radioactivity on idle surfaces of gear teeth.

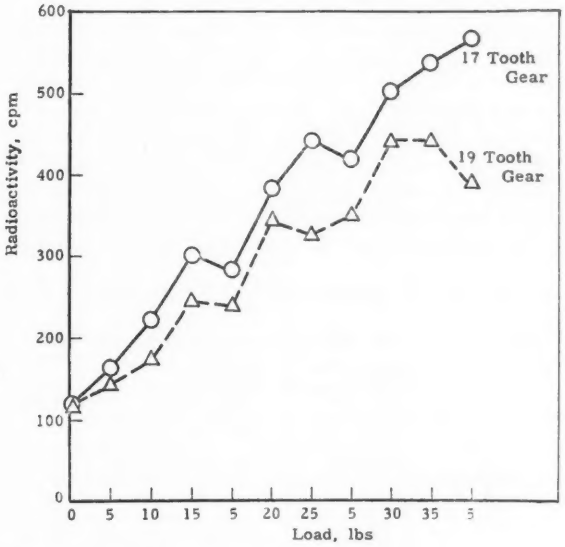

Figure 11. Radioactivity on side of gears.

volume of a sulfur atom is 26.6×10^{-24} cm.^{3}, and a monolayer is 2.98 A° or 0.0117 micro-inches thick. One milligram of sulfur per cm.^{2} is equivalent to 16.800 monolayers or 197 micro-inches.

Safety Considerations

The principal problem in the handling of sulfur S^{35} is the prevention of contamination of tools, laboratory, and personnel. Neoprene gloves were worn, special steel tools were used for handling parts contaminated with the radioactive oil, and a monitor with a thin-window Geiger counter was used to detect contamination at each stage in the operation.

In experiments involving the oil at elevated temperatures, exhaust ventilation was provided to prevent accumulation of radioactive vapor in the working space.

RESULTS & DISCUSSION

Reaction of Iron with Dibenzyl Disulfide in Oil

The reaction of iron with the additive was tested by immersing appropriately preheated steel strips in the radioactive oil at various temperatures for various lengths of

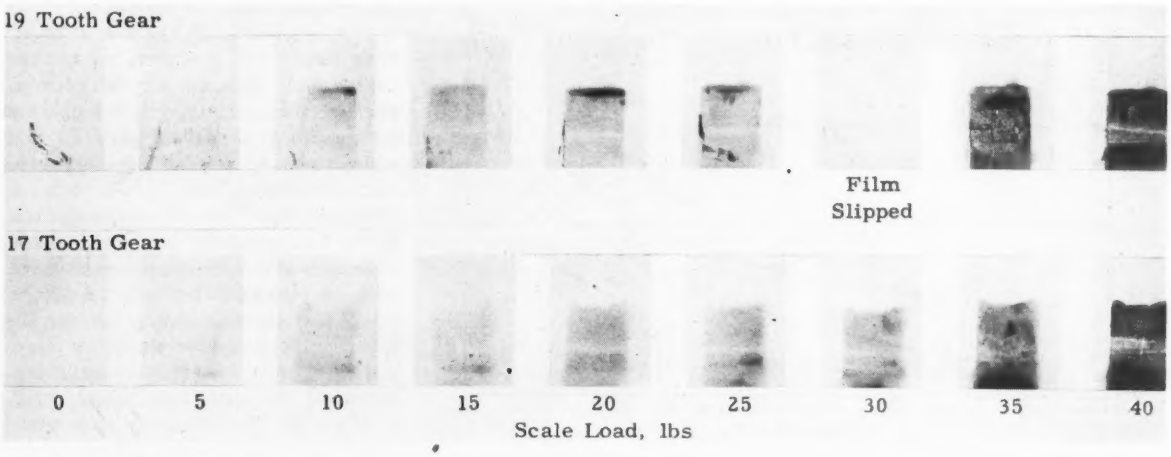

Figure 12. Radiographs of tooth working surfaces.

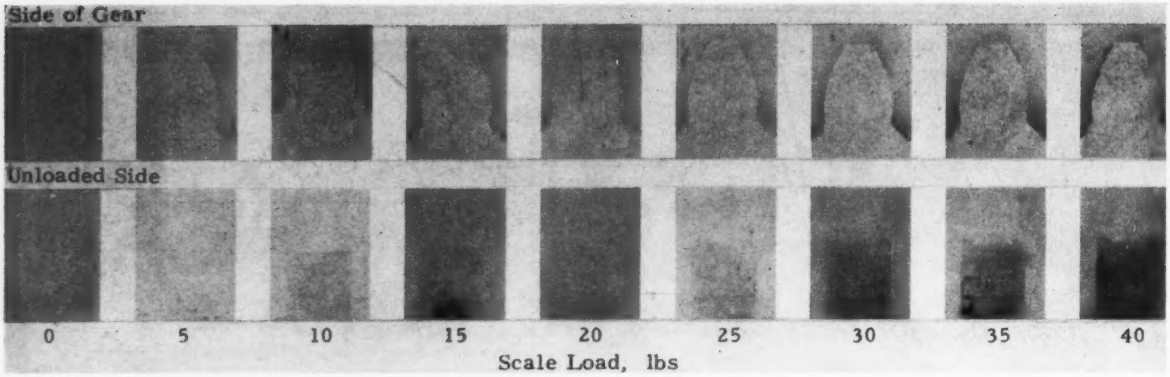

Figure 13. Radiographs of 17-tooth gear.

time. The strips on removal were washed with solvent in the same manner as that used with the gears. The residual activity on the surface was determined by counting with the thin-window counter. Results are plotted in Figure 6. The data are rather scattered, but they show a sharply-increasing reaction rate with time, particularly in the experiments performed at higher temperatures. The reason for the autocatalytic character of the reaction is not clear.

It had been hoped that these experiments would provide data by which one might determine the working temperatures of the gear teeth, using the amount of sulfur deposited as the criterion. However, the scatter of the data and the autocatalytic nature of the reaction make this approach uncertain.

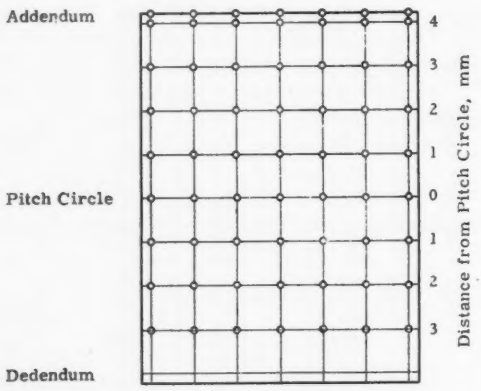

Figure 14. Points of the radiograph of tooth surface where optical density was measured.

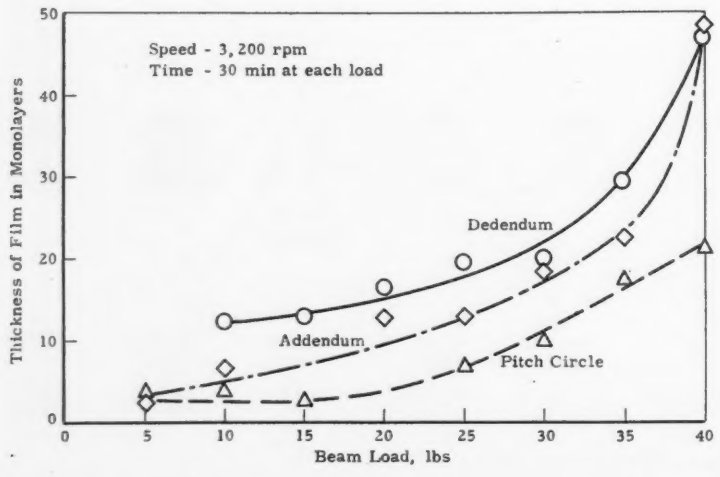

Figure 15. Thickness of E.P. film on 17-tooth pinion at various loads.

Experiment with Gears

In experiments with the actual gears, the general level of radioactivity of the gear teeth was measured as shown in Figure 3. Obviously the readings so obtained give only a comparative measure and are of value for the general estimation of the effect of operating variables. Those data are presented in a graphical form in Figure 7 for the 17-tooth gear, and in Figure 8 for the 19-tooth gear. The radioactivity in counts per minute was plotted as a function of load. The curves show that radioactivity increased with load, that duration of running apparently had no definite effect, and that radioactivity emitted from the 17-tooth gear was slightly higher than that from the 19-tooth gear.

The results of shielded measurements are given in Figure 9 for the working surfaces of the gear teeth, in Figure 10 for the idle surfaces, and in Figure 11 for the sides of the gears. These charts show that radioactivity emitted from the working surfaces and the sides of the teeth increased with the increase in load, while for the idle surfaces, changes in radioactivity with load were very small. Since all the heat is generated on the working surface, it is obvious that it should be more sensitive to the changes in operating conditions than the idle surface of the tooth.

In order to study the film in more detail, the working surfaces were autoradiographed after running the gears at each operating condition. A few of these radiographs are shown in Figure 12. Idle surfaces and the sides of the teeth were also autoradiographed. Some of these are presented in Figure 13. Examination of the radiographs of the working surfaces show that their intensities increased with the increase in load. It can also be noted that on each radiograph the intensity is minimum at the pitch circle, and it increased toward both the addendum and the dedendum. The radiographs of the idle surfaces are much weaker in their intensities and uniform in appearance.

To obtain quantitative data on the distribution of the film on these surfaces, optical densities of the radiographs were measured, as shown in Figure 14. The data for optical densities were converted into intensity of radioactivity in cpm/cm.^{2} by means of the chart given in Figure 5, and these values in turn, after correction for decay (half-life of $S^{35} = 87$ days), were converted into film thickness expressed as number of monolayers. The variations of film thickness with load at the pitch circle, the addendum, and the dedendum for the 17-tooth gear are presented graphically in Figure 15, and for the 19-tooth gear in Figure 16. These two charts show that film thickness on the working surfaces of the teeth increased with load. Comparison of the films on the 17-tooth gear and on the mating 19-tooth gear show that on the pitch circle film thicknesses are similar on both gears, that film thickness at the addendum of the 17-tooth gear corresponds to film thickness at the dedendum of the 19-tooth gear, etc. In spur gears operation, the addendum of one gear mates with the dedendum of the other, and the pitch circles of both gears are common. The results, therefore, are a measure of the reliability of the data. The thickness of the films on the idle surface of gear teeth and its relation to load are shown in Figure 17. Here, as in the case of the radioactivity obtained by direct measurements with the Geiger-Muller counter, variations in film thickness with load were small.

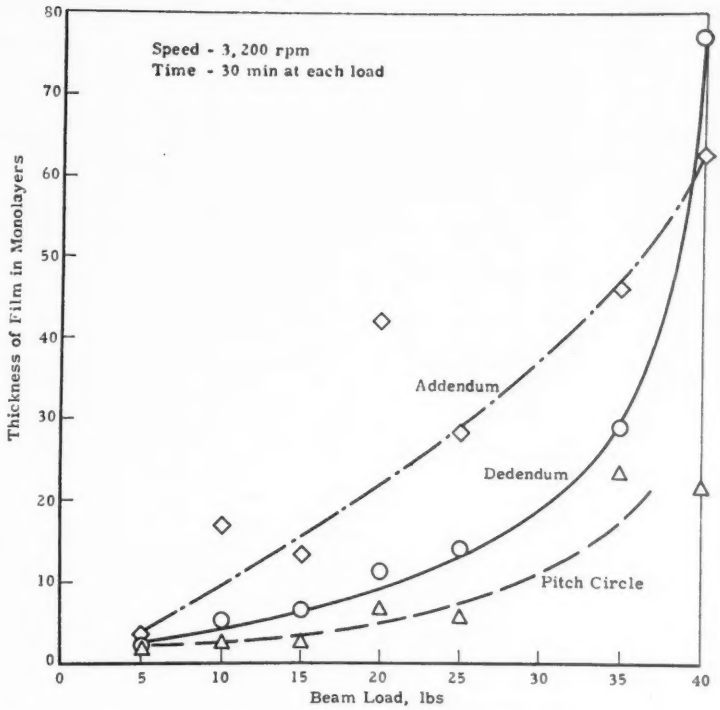

Figure 16. Thickness of E.P. film on 19-tooth gear at various loads.

The distribution of the film along the active profile was obtained by dividing the working tooth surface into nine lines, as shown in Figure 14, and establishing film thickness at each line. The data for a run at 40-pounds scale load is shown in Figure 18. The curves show that the minimum thickness on both gears occurred at the pitch circle, and that film thickness gradually increased toward both the addendum and the dedendum. However, on the addendum part of the teeth the maximum thickness occurred not at the tip, but somewhat below. At 40-pounds scale load (corresponding to 2880 pounds per inch), scoring occurred which relieved the parts adjacent to the tips.

From Figure 7 and Figure 8, where radioactivity emitted from the gear teeth was plotted as a function of load for three different durations of running, it was concluded that duration of operation, at least within the limits of these tests, has no direct influence on the thickness of extreme-pressure film. It was also postulated that for each set of operating conditions an appropriate steady-state thickness of the film was established. To check this conclusion, during the test performed with 3 hours duration at each load, the scale load was decreased several times to 5 pounds. Each such decrease in load was accompanied by a decrease in the thickness of the film. This is shown in Figure 19 where radioactivity from unshielded gears was plotted against load, and in Figure 20 where film thickness on the 17-tooth gear was given.

CONCLUSIONS

1. The distribution and thickness of sulfur-containing E.P. films on actual gear surfaces has been reliably determined by employing a sulfur 35 containing E.P. agent and autoradiography as a measurement technique.

2. Iron surfaces react with dibenzyl disulfide in oil in an autocatalytic manner. The reaction rate is highly temperature-dependent.

3. The thickness of the iron-sulfide films formed on the working surface of the gear teeth increases with increase in load and is little (if at all) affected by time.

4. An appropriate steady-state thickness of E.P. film is established for each operating condition, indicating that

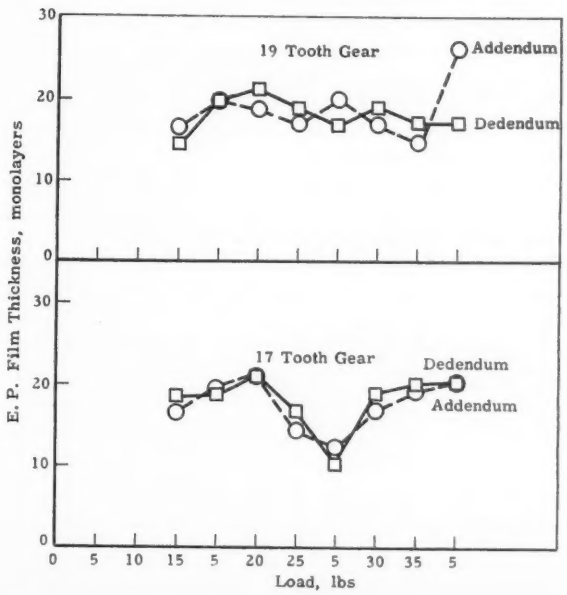

Figure 17. E.P. film thickness on idle tooth side.

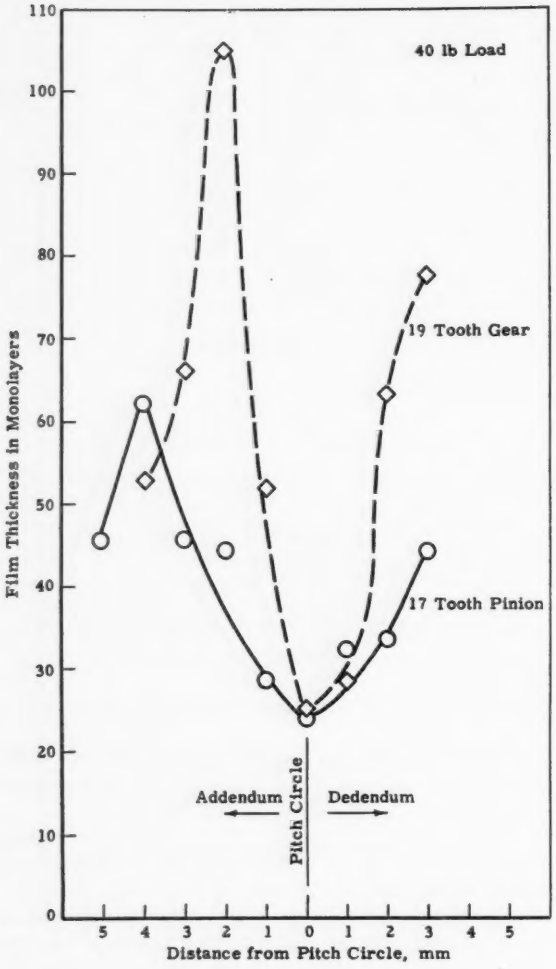

Figure 18. Thickness of E.P. film along gear tooth.

the film is being formed and attrited continuously during the operation.

5. On the working surface of the tooth, the thickness of the E.P. film is minimum at the pitch circle, and it gradually increases toward the addendum and the dedendum. This indicates that the film thickness is controlled by local or contact temperature.

6. An E.P. film forms also on the idle side of the tooth. Here it is thinner and more uniform in thickness than on the tooth working surface.

7. Dibenzyl disulfide in an oil solution undergoes little reaction with the inoperative parts of the gear, such as its rim.

8. The maximum thickness of the E.P. film observed in these experiments was 1.2×10^{-6} inch, which is smaller than the average height of the projecting asperities of a surface finished to 20 micro-inches.

BIBLIOGRAPHY

1. Bridgeman, O. C., "The Problem of Extreme Pressure Lubricants," *Proc. A.P.I., 13*, Sec. III, December 1932, p. 114.
2. Mougey, H. C., and Almen, J. D., "Extreme Pressure Lubricants," *Proc. A.P.I., 12*, Sec. II, November 1931, p. 76.
3. Prutton, C. F., and Turnbull, D., "Mechanism of Action of Organic Chlorine and Sulphur Compounds in Extreme Pressure Lubrication," *J. Inst. Petroleum, 32*, 90-118 (1946).

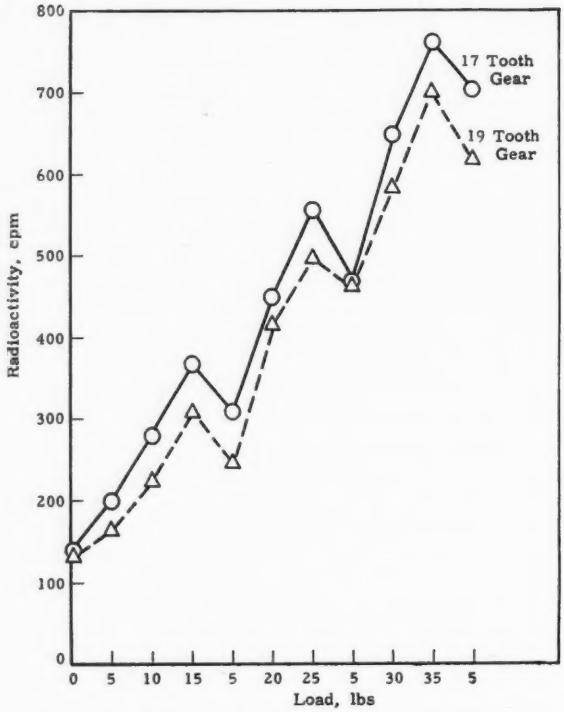

Figure 19. Radioactivity from unshielded gear teeth.

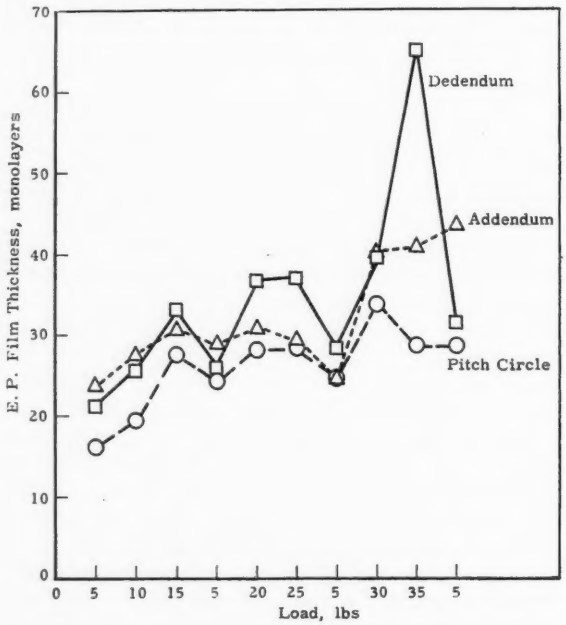

Figure 20. E.P. film thickness on loaded side on 17-tooth gear at various loads.

4. Beeck, O. A., Givens, J. W., Williams, E. C., "On the Mechanism of Boundary Lubrication. Wear Prevention by Addition Agents," *Proc. Roy. Soc., A177*, 103 (1940).
5. Clark, G. L., Gallo, S. G., and Lincoln, B. H., "Radiosulfur Tracer Study of Sulfurized Lubrication Addition Agents," *J. Applied Phys., 14*, 428-434 (1943).

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COMMENTARY

A. BONDI, SHELL DEVELOPMENT CO.

The practical significance of the authors' results might be brought out a bit more clearly by adopting a somewhat different interpretation of the data. Bowden's mechanism (the successive engagement of lower peaks among the randomly distributed surface asperities as the load is raised) leading to proportionality between the true contact area and the load, suggests that the rise in (radioactive) sulfur concentration on the surface with gear loading corresponds to an increase in the true contact area rather than an increase in thickness of the sulfurized layer. Quantitative resolution of the autoradiographs to discern between the thickness and the area hypothesis is not possible at present.

Even if most of the sulfur "deposition" were due to spread in true contact area, a certain amount of growth in depth of reacting layer with increasing load (=temperature) will occur. The superposition of the two effects leads to the (observed) greater than proportianal rise of sulfur deposition with load, where as the "area-hypothesis" would require strict proportionality between the two.

Following the independent determination or calculation of the sulfide film thickness on the tops of the individual asperities, the observed average sulfur concentration on the surface is a direct measure of the amount of solid contact which the E.P. agent permits before seizure occurs. From this information one can then obtain the fraction of the load carried by the hydrodynamic film and that carried by solid contact. While evidence suggests that in the absence of E.P. additives seizure occurs when about 2% of the gear load is carried by solid contact, one can estimate from the authors' data that with dibenzyldisulfide (to 0.5% S in SAE 30 oil), about 20% of the gear load is carried by solid contact when seizure occurs.

COMMENTARY

H. R. JACKSON, THE ATLANTIC REFINING CO.

The paper by Messrs. Borsoff and Wagner on extreme-pressure film studies using radiosulfur is most informative. One of the most interesting aspects is their use of autoradiographs on a quantitative basis. This technique is often used for comparative type measurements; but here, through careful calibration, the authors determined actual film thicknesses. I would like to offer the following questions and comments which I hope will aid in the understanding of the paper.

Were one set of gears used for all of the experiments? Were the gears "run-in" before actual testing started?

In the general activity measurements of the gear tooth working surfaces as shown in Figure 3, the authors state that the recorded data is the average of five readings. What sort of variances were found in these individual readings?

Figure 6 is a logarithmic plot of surface activity versus time of immersion for steel strips at various temperatures. On such a plot, a constant rate of reaction would be a 45° line. Any line with a slope less than this would indicate a diminishing reaction rate. Most of these data, subsequent to the first few minutes of immersion, give an approximate 45° slope. I question the authors' use of the term autocatalytic to describe these results. What was the condition of the steel strips prior to their immersion? If they were dry or wet with a blank oil, this may explain the initial delay in the start of the reaction.

The authors state that Figures 7 and 8 show no definite effect of duration of running the gears on gear teeth activity level. This is certainly a reasonable conclusion. However, a trend may be indicated, particularly at the heavier loads, for less E.P. film to be present after the 3 hour running time compared to the shorter periods. Since iron sulfide is continually being formed and rubbed off during running, isn't it possible that less chemically active sulfur is present in the lubricant after extended running? Do the authors feel that this may be a significant factor? Do they have any data showing the effect of dibenzyl sulfide concentration on film thickness?

The counts per minute data in Figures 9, 10, and 11 indicate highest activity on the sides of the gears. The autoradiographs shown of these parts in Figure 13 are not particularly dark. What is the reason for this apparent discrepancy?

It is sincerely hoped that Messrs. Borsoff and Wagner will continue this line of research with other E.P. agents, including phosphorous and chlorine compounds as well as sulfur. It is work such as this that will help complete the change of gear lubrication from an art into a science. The authors are to be congratulated for a fine piece of work.

COMMENTARY

E. RABINOWICZ

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

The authors are to be congratulated for their paper which is a valuable addition to our knowledge both as to the use of radioisotopes and as to the mechanism of E.P. lubrication. One point which I feel the authors might have emphasized is the occurrence of radioactivity in localized spots rather than as a uniform deposit on the gear-tooth surfaces. Two mechanisms readily suggest themselves to explain this effect:

(1) The localized temperature flashes at the real points of contact lead to increased chemical reaction.

(2) Naked metal produced at the real points of contact has a greater chemical reactivity.

At very low speeds we would expect mechanism (1) to be less effective and mechanism (2) to be equally effective, assuming that in each case the total sliding distance is the same. I wonder whether the authors have any information on this point.

AUTHORS' CLOSURE

The authors are in full agreement with Mr. Bondi's suggestion that a portion of the rise of the radioactivity could be attributed to an increase of actual contacting area with load. Unfortunately, no method for evaluation of actual contact on micro scale is known; and this work, therefore, was based on an assumption that the surfaces investigated were uniformly covered by the extreme-pressure film. Additional evidences supporting the theory of the growth of the films in depth are: (a) decrease of load caused a decrease in the radioactivity emitted from the surfaces; (b) the lack of strict proportionality between changes in load and radioactivity. The resolution of this question and the elucidation of the true nature of contact are of considerable importance and studies along this line are being continued.

The method for evaluating the relative amount of solid contact and area supported by thick (hydrodynamic) film, as mentioned by Mr. Bondi in the second part of his comments, is most interesting, and the authors suggest that Mr. Bondi soon disclose this method in the published literature.

Mr. Rabinowicz' interesting suggestion that radio activity on the gear teeth working surfaces formed on localized spots, rather than as a uniform deposit, unfortunately, cannot be verified by our data, because no method to study the distribution of the radioactivity on such a micro scale is known to these authors.

Answering Mr. Jackson's questions:

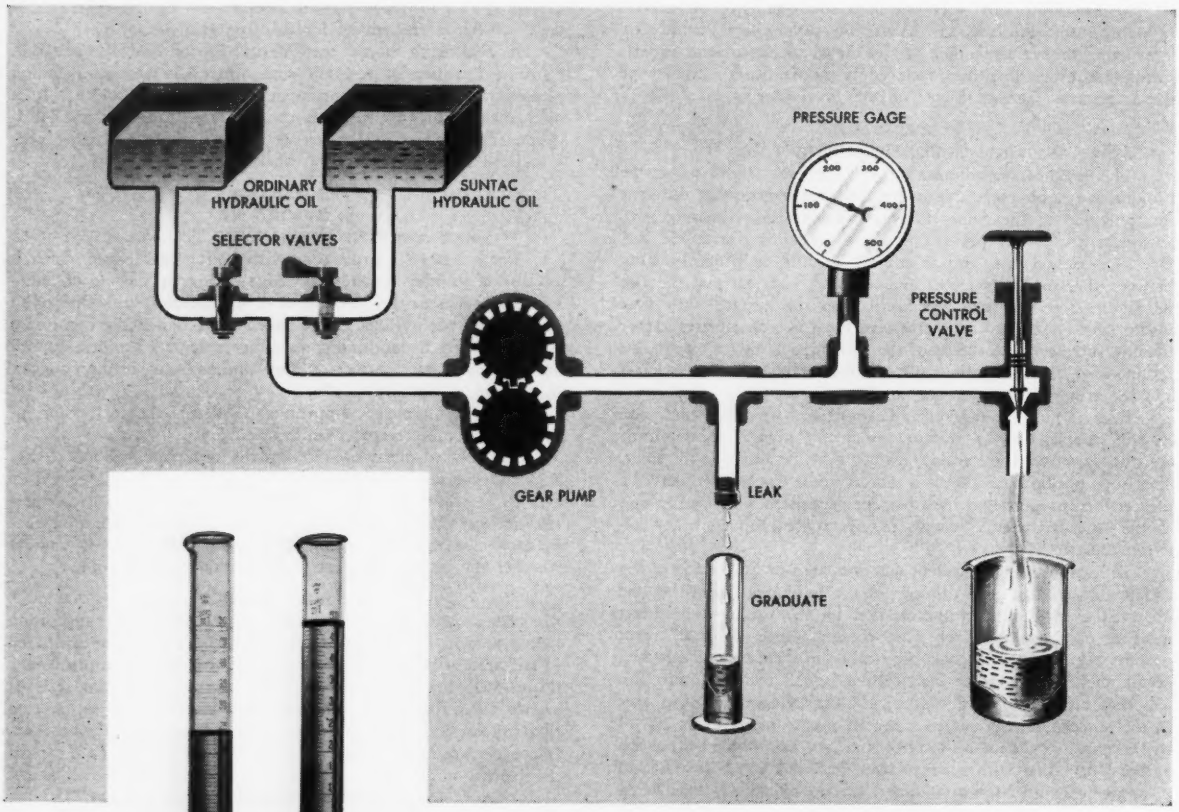
For each series of experiments, only one set of gears was used which were not "run-in."

Each radioactivity reading given represented an average of five teeth. The average variations between these individual readings were about 7%. They were slightly greater when cpm were below 100.

Mr. Jackson is quite correct in pointing out that a 45° line on a logarithm plot represents a constant rate. The steel strips used were cleaned by abrasion with 000 emery paper and wiped with "Kleenex" tissues. They were not blanked with oil prior to their immersion into the test oils. The nature of the chemical reactions occurring between extreme-pressure agents and metals is of considerable importance, and merits further investigations.

Mr. Jackson suggests that the apparent effect of duration of runing on the thickness of the film (Figures 7 and 8) is real, and that this may be due to depletion of the active agent. We are not convinced the effect is real, but the suggestion is highly appreciated and the question certainly merits further investigation.

The high measured activity of the side of the gears compared to that of the working surfaces, in spite of the opposite effect in autoradiographs density, was due to the difference in geometry under which the counting was performed. The working surfaces were counted under the geometry as shown in Figure 3, while the side of the gears. being flat, were counted directly by placing the Geiger tube at 0.015 in. distance.



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(Lube in the News, from p. 90)
which help keep the oil fluid at low temperatures. Acrylamide derivatives are also employed as viscosity index improvers which prevent the oil from becoming too thick at low temperatures or too thin at high temperatures.

(6) Color stabilizers prepared by condensing aromatic aldehydes with diethylene triamine. (Reprinted in part from "Chemical Progress," Vol. 2, July 1956.)

Cuban Congress on Petroleum. An industry exhibit open to the public at large is planned as part of the activities of the 2nd Cuban Congress on Petroleum scheduled to be held in Havana, May 5-11.

Dr. Alberto Diaz Masvidal, President of the Organizing Committee, states that the working sections will comprise six: (1) Geology, Geophysics & Geochemistry, (2) Drilling & Production, (3) Processing, Distribution & Utilization, (4) Research, Development & Testing, (5) Education and Training of Personnel, and (6) Management, Economics & Law.

For more detailed information regarding the event, write: II Cuban Petroleum Congress, Edificio Habana 800, Havana, Cuba.

Personals

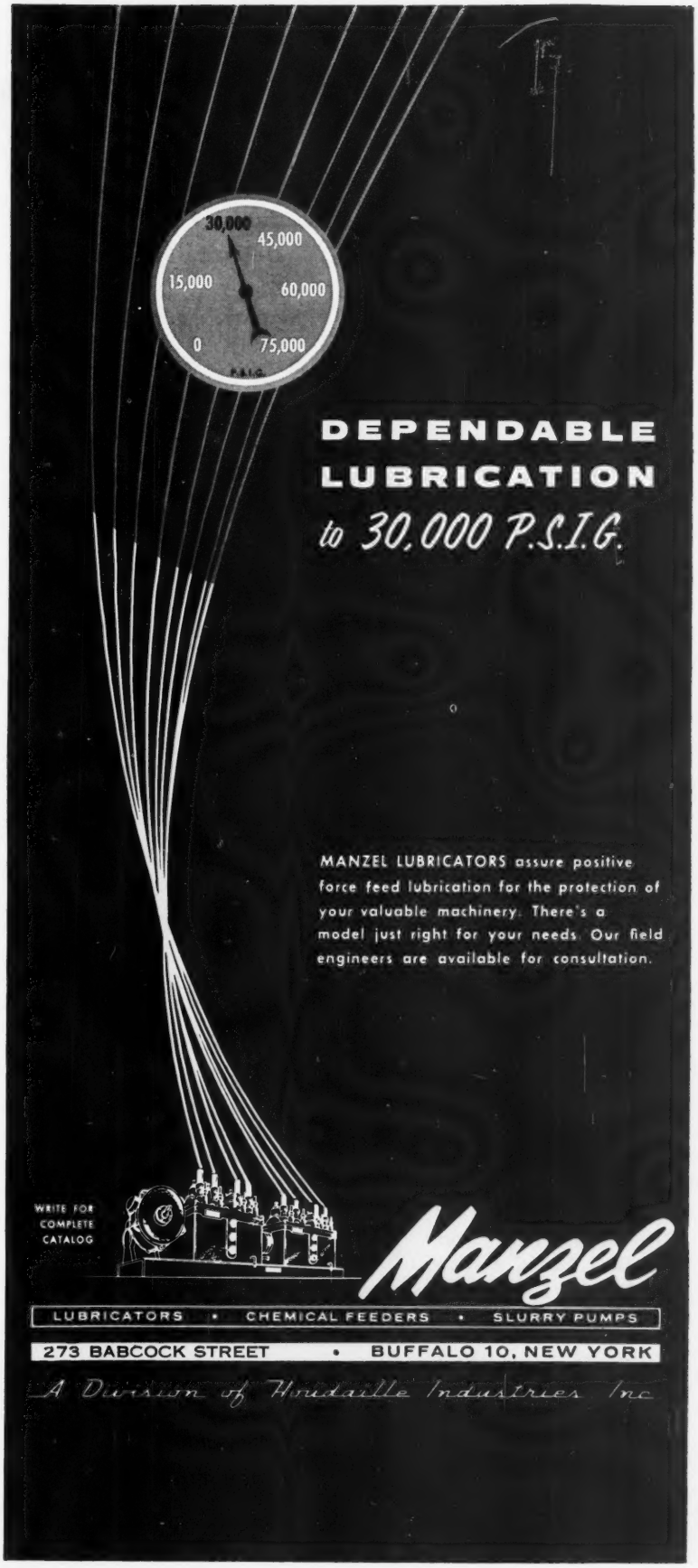
A. K. Hoge (ASLE Connecticut Section) has accepted a position with the Pla-Tank Div. of Haveg Industries, West Warren, Mass.

T. G. Timberlake has been appointed Chief of the Mechanical Engineering Dept. at the Corps of Engineers' Research & Development Laboratories, Fort Belvoir, Va.

General Electric Co. has announced the creation of two new sales districts for its Silicone Products Dept., Waterford, N. Y., with M. C. Lauenstein and R. T. Daily as District Managers of the Chicago and Western (Los Angeles) Sales Districts, respectively.

G. L. Pitzer has been appointed Vice-President — Pro-

(Continued on p. 106)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ASLE 12th

ANNUAL MEETING PROGRAM

(Tentative)

April 15, 16, 17, 1957
Sheraton Cadillac Hotel
Detroit, Michigan

Monday, April 15, 1957

9:00 A.M. Business Meeting

10:00-11:30 A.M.

SESSION 1A Wear of High Temperature Seals Material

R. W. Blair, Chicago Rawhide Mfg. Co., Chicago, Ill., Organizing and Session Chairman

1. "WEAR OF CARBON TYPE SEAL MATERIAL WITH VARIED GRAPHITE CONTENT."
   Max A. Swikert, R. L. Johnson, Lewis Flight Propulsion Laboratories, Cleveland, Ohio
2. "FRICTIONAL PROPERTIES OF HIGH TEMPERATURE SEAL MATERIAL."
   Joseph F. Cerness, Carol Pilarczyk, Douglas H. Strong, Cleveland Graphite Bronze Co., Cleveland, Ohio

SESSION 1B Environmental Factors VS Lubrication Effects

A. W. Lindert, Standard Oil (Indiana), Whiting, Ind., Organizing and Session Chairman

1. "SOME EFFECTS OF GAMMA RADIATION ON COMMERCIAL LUBRICANTS."
   J. G. Carroll, S. R. Calish, California Research Co., Richmond, Calif.
2. "EFFECTS OF ENVIRONMENT ON RUST INHIBITORS AND OXIDATION STABILITY OF LUBRICATING OILS."
   A. Mertwy, M. Trachtman, J. Messina, H. Gissor, Frankfort Arsenal

SESSION 1C Automatic Lubrication Equipment

E. M. Higgins, Master Lubricants Co., Philadelphia, Pa., Organizing Chairman, Donald H. Wilson, Continental Steel Co., Kokomo, Ind., Session Chairman

1. "CIRCULATING OIL SYSTEMS."
   N. S. Robson, Trabon Engineering Corp., Cleveland Ohio
2. "OIL MIST LUBRICATION."
   D. G. Faust, C. A. Norgren Co., Englewood, Colorado

SESSION ID Lubrication Engineering Course

SESSION IE Exhibits

2:00-4:30 P.M.

SESSION 2A Metal Working Fluids

H. L. Shaw, Battelle Memorial Institute, Organizing and Session Chairman

1. "STAMPING AND DEEP DRAWING LUBRICANTS — WHAT ARE THEY?"
   Leon Salz, Magnus Chemical Co., Garwood, New Jersey
2. "CONVERSION COATINGS AID THE LUBRICATION OF TITANIUM."
   Earl White, P. O. Miller, Battelle Memorial Institute, Columbus, Ohio
3. "TEST FOR EVALUATING CUTTING FLUIDS."
   H. W. Husa, W. L. Buckley, Standard Oil Co. of Indiana
4. "LABORATORY EVALUATION OF CUTTING FLUIDS."
   H. A. Hartung, Atlantic Refining Co., Philadelphia, Pa.

SESSION 2B Hydrodynamic Bearings

Fred Macks, Air Guide Engineering Laboratories, Vermilion, Ohio, Organizing and Session Chairman

1. "A SOLUTION FOR THE FINITE JOURNAL BEARING AND ITS APPLICATION TO ANALYSIS AND DESIGN —III."
   A. A. Raimondi, John Boyd, Westinghouse Research Laboratories, Pittsburgh, Pa.
2. "THE EFFECT OF BEARING DEFORMATION IN SLIDER BEARING LUBRICATION."
   F. Osterle, E. Saibel, Carnegie Tech., Pittsburgh, Pa.
3. "SOME MECHANICAL CONSIDERATIONS IN THE DESIGN OF LARGE THRUST BEARINGS."
   R. A. Baudry, G. E. Peterson, Westinghouse Electric, Pittsburgh, Pa.
4. "SOLUTION OF REYNOLDS AND ENERGY EQUATIONS FOR SECTOR THRUST BEARINGS."
   B. Sternlicht, General Electric Co., Schenectady, New York

SESSION 2C New Greases for Problem Application

Harry W. McCulloch, Jr., Shell Oil Co., Wood River, Ill., Organizing Chairman, J. W. Lane, President, NLGI, Socony-Mobil Oil Co., Session Chairman

1. "PERFORMANCE OF AN INORGANIC MICROGEL GREASE IN INDUSTRIAL APPLICATIONS."
   J. A. Bell, Shell Oil Co.. New York, New York
2. "SERVICE EXPERIENCE WITH A NEW MULTI-PURPOSE INDUSTRIAL GREASE."
   S. R. Calish, Jr., California Research Corp., Richmond, Calif.
3. "A NEW THICKENER FOR MULTI-PURPOSE INDUSTRIAL GREASE."
   W. L. Hayne, D. R. Oberlink, R. J. Rosscup, Standard Oil Co., (Indiana), Chicago, Ill.

SESSION 2D Lubrication Engineering Course

SESSION 2E Exhibits

Tuesday, April 16, 1957

9:30-11:30 A.M.

SESSION 3A Specifying Lubrication for Industry

H. McCulloch, Jr., Shell Oil Co., Wood River, Ill., Organizing Chairman, A. R. Black, Shell Oil Co., New York, New York, Session Chairman

1. "LUBRICATION STANDARDS FOR INDUSTRIAL EQUIPMENT."
   S. O. Kimball, A. C. Spark Plug Co., Flint, Michigan
2. "LUBRICATION IN A GLASS CONTAINER MANUFACTURING PLANT."
   D. E. Grube, Owens-Illinois Glass Co., Toledo, Ohio
3. "LUBRICATION IN A CHEMICAL PLANT."
   R. W. Clark, E. I. du Pont de Nemours & Co., Wilmington, Delaware

SESSION 3B Performance, Design and Operation of Rolling Contact Bearings

A. A. Raimondi, Westinghouse Research Laboratories, Organizing and Session Chairman

1. "DESIGN AND OPERATION OF BALL BEARINGS FOR USE IN PRESSURIZED WATER SYSTEMS."
   P. R. Eklund, Westinghouse Electric Co., Pittsburgh, Pa.
2. "THE TORQUE AND WEAR OF WATER LUBRICATED BALL BEARINGS AS RELATED TO CERTAIN DESIGN PARAMETERS."
   W. H. Goldwaite, C. M. Allen, and D. W. Knoll, Battelle Institute, Columbus, Ohio
3. "ROLLING CONTACT BEARINGS FOR NON-LUBRICATING SERVICE."
   B. E. Murphy, J. K. Elbaum, Haynes-Stellite Co., Kokomo, Ind.

SESSION 3C Lubrication Fundamentals

Dr. E. G. Jackson, General Electric Co., Lynn, Mass., Organizing and Session Chairman

1. "THE NON-NEWTONIAN CHARACTERISTICS OF LUBRICATING OILS."
   Theodore W. Selby, General Motors Research, Warren, Michigan
2. "MEASUREMENTS ON POLYMER MODIFIED LUBRICATING OILS AT HIGH RATES OF SHEAR."
   Dr. Waldmir Philipoff, Franklin Institute
3. "EXPERIMENTAL INVESTIGATION OF THE CORROSIVE COMPONENT OF MECHANICAL WEAR."
   Raymond H. Baskey, F. C. Wagner and J. T. Burwell, Horizons, Inc., Cleveland, Ohio
4. "IS BOUNDARY LUBRICATION A MYTH?"
   W. Lewicki, Imperial College of Science and Tech nology, Dept. Chemical Engineering, London, England

SESSION 3D Lubrication Engineering Course

SESSION 3E Exhibits

2:00-4:30 P.M.

SESSION 4A The Nature of Chemisorbed Lubricant Films

E. M. Kipp, Session Chairman, Dr. Herman Reis, Standard Oil Co., of Indiana, Organizing Chairman

1. "CHEMICAL NATURE OF EXTREME PRESSURE LUBRICATION."
   Dr. G. Hugel, Institut Francais Du Petrole, Paris, France
2. "ADSORPTION AND FRICTION STUDIES OF LUBRICANT ADDITIVES."
   Arnold Miller, Borg-Warner Corp., Des Plaines, Ill.
3. "A THEORETICAL CRITERIA FOR THE EFFECTIVENESS OF A LUBRICANT FILM."
   Ernest Rabinowicz, M.I.T., Cambridge, Mass.
4. "RECENT RUSSIAN RESEARCH ON CHEMISORBED LUBRICANT ADDITIVES."
   Douglas Godfrey, California Research Corp., Richmond, Calif.
5. "APPROACH TO FRICTION AND BOUNDARY LUBRICATION FROM THE DISLOCATION THEORY OF FRICTION."
   John H. Dismant, Consultant Research Engineer, Grand Junction, Colorado

SESSION 4B Automation Lubrication Practices in the Automotive Industry

Roger Hendrick, Reynolds Metals Co., Richmond, Virginia, Organizing and Session Chairman

1. "STANDARDIZATION OF PLANT LUBRICANTS AND LUBRICATION PRACTICES."
   R. O. Kageff, Ford Motor Co., Detroit, Michigan
2. "INCREASED MACHINE PRODUCTIVITY DEMANDS WELL-DESIGNED LUBRICATION PRACTICES."
   Robert H. Guy, Detroit Transmission Division, General Motors Co., Ypsilanti, Michigan
3. "ESTABLISHING LUBRICATION PRACTICES IN AN AUTOMATED ENGINE PLANT."
   D. F. Miller, Engineering Division, Chrysler Corp., Detroit, Mich.

SESSION 4C Rolling Contact Bearings

J. H. Gustafson, Marlin Rockwell Corp., Organizing and Session Chairman

1. "GREASE LUBRICATION IN ULTRA HIGH LOAD ROLLER-CONTACT BEARINGS."
   J. B. Ancinelli, Shell Development Co., Emeryville, Calif.
2. "THE EFFECT OF L. RIBBON AND SPRING TYPE SEPARATORS ON THE STARTING TORQUE OF AN R4D BEARING."
   John C. Lawrence, Air Research Mfg. Co., Los Angeles, Calif.

SESSION 4D Lubrication Engineering Course

SESSION 4E Exhibits

6:30-9:30 P.M. Cocktail Party and Annual Awards Banquet

Wednesday, April 17, 1957

9:30-11:30 A.M.

SESSION 5A Requirement for Automotive Hypoid Gear Lubrication

R. O. Kageff, Ford Motor Co., Detroit, Mich., Organizing and Session Chairman

1. "NEW DEVELOPMENTS IN GEAR LUBRICANTS."
   C. M. Heinen, Chrysler Corp., Detroit, Michigan
2. "PROBLEMS ASSOCIATED WITH MARKETING GEAR LUBRICANTS."
   A. A. Manteuffel and J. B. Stucker, Pure Oil Co., Crystal Lake, Ill.

3. "CRC EVALUATION OF NEW GEAR LUBRICANTS."
T. P. Sands, Monsanto Chemical Co., St. Louis, Mo.
4. "FIELD PROBLEMS IN HYPOID REAR AXLES."
J. E. Cardillo, Ford Motor Co., Dearborn, Mich.
5. "CHEMICAL ADDITIVES FOR HYPOID GEARS."
Dr. R. A. Asseff, Lubrizol Co., Cleveland, Ohio

SESSION 5B Railroad Journal Bearings

L. E. Hoyer, American Brake Shoe Co., Detroit, Mich., Organizing and Session Chairman

1. "FRICTION AND OIL FEED CHARACTERISTICS OF JOURNAL BOX BEARINGS."
George L. Pigman, Caterpillar Tractor Co., Peoria, Ill., and W. M. Keller, AAR
2. "CAR OIL ADDITIVES."
Ray McBrian and L. C. Atchinson, Denver & Rio Grande Western R.R., Denver, Colo.
3. "PROGRESS REPORT ON HOT BOXES."
Victor C. Barth, Chicago and Northwestern R.R.
4. "PROGRESS REPORT ON USE OF MOLYBDENUM DISULFIDE IN RAILROAD JOURNAL BEARINGS."
E. E. Smith, Climax Molybdenum Co., New York, New York

SESSION 5C Lubricating Mechanisms of Solids Lubricants

Robert L. Johnson, National Advisory Committee on Aeronautics, Cleveland, Ohio, Organizing and Session Chairman

1. "PLASTICS, SOLID LUBRICANTS, AND BEARINGS."
A. J. G. Allan, Polymer Chemicals Dept., E. I. du Pont de Nemours & Co., Inc.
2. "MOLYBDENUM DISULFIDE AND RELATED SOLID LUBRICANTS."
Bernard C. Stupp, Hohman Plating & Mfg. Co., Inc., Dayton, Ohio
3. "MECHANISM OF WS_2 LUBRICATION IN VACUUM."
Melvin T. Lavik, Midwest Research Institute, Kansas City, Missouri
4. "FRICTION OF TEFLON AS A DRY LUBRICANT BEARING."
S. B. Twiss, P. J. Wilson, and E. J. Snyder, Chrysler Corp., Engineering Div., Detroit, Michigan

SESSION 5D Lubrication Engineering Course

SESSION 5E Exhibits

2:00-4:30 P.M.

SESSION 6B Lubrication Equipment

E. M. Higgins, Master Lubricants Co., Organizing Chairman

T. M. Murphy, Stewart-Warner Corp., Chicago, Ill., Session Chairman

1. "FILTRATION OF COOLANTS."
Gordon Signor, Scovill Mfg. Co., Waterbury, Conn.
2. "FILTRATION OF LUBRICATION OILS."
Herbert A. Wilson, Commercial Filters Co., Melrose, Mass.
3. "FILTRATION OF DIESEL ENGINE OILS."
W. King Simpson, Electromotive Corp., La Grange, Illinois

SESSION 6C Lubrication of Non-Ferrous Metals and Surfaces

Dr. L. B. Sargent, Jr., Organizing and Session Chairman, Aluminum Co. of America, Pittsburgh, Pa.

1. "WEAR AND FRICTIONAL CHARACTERISTICS OF SOME WROUGHT AND CAST NICKEL BASE ALLOYS."
R. B. Kozlik, International Nickel Co.
2. "MILL AND LABORATORY EVALUATION OF OILS FOR ROLLING OF COPPER ALLOYS."
F. L. Reynolds, Bridgeport Brass Co.
3. "FRICTIONAL CHARACTERISTICS OF AIRCRAFT WHEEL BRAKE MATERIALS."
Dr. C. Sump, Armour Research Foundation, Chicago, Ill.

SESSION 6D Reclamation and Maintenance

N. C. Penfold, Southwest Research, San Antonio, Texas, Organizing Chairman

1. "FILTRATION OF MOTOR OIL."
J. R. Griffin, Jr., Dev. Head, Lubrication Oil Petroleum Lab., E. I. du Pont de Nemours Co.
2. "LUBRICATION PROBLEMS ASSOCIATED WITH LARGE COMPRESSOR STATIONERY ENGINES."
Clyde M. Floyd, Humble Oil & Refining Co., Houston, Texas

SESSION 6D Exhibits

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ANNOUNCES

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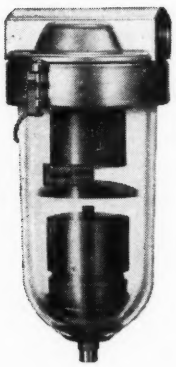

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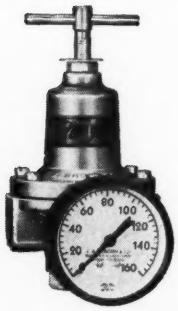

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(Personals, from p. 101)

duction, of the Bakelite Co., Div. of Union Carbide & Carbon Corp., N. Y., N. Y.

W. D. Regnier has been appointed Division Manager of Sales — Machinery Div., of the Crown Cork & Seal Co., Inc., Baltimore, Md.

The Texas Co. has announced the following appointments: R. J. Ronan as Regional Manager, and E. F. Koenig as Technical Representative, of their Technical Services Div., Research & Development Dept., with headquarters in Beacon, N. Y.

W. Kujala has been appointed Eastern District Sales Manager of the Gits Bros. Manufacturing Co., Shaft Seal Div., with headquarters at 36 Grand Ave., Englewood, N. J.

W. E. Johnson has been named Manager of Alcohol & Chemical Sales for U. S. Industrial Chemicals Co., Div. of National Distillers Products Corp., N. Y., N. Y.

T. A. Treleaven has been appointed Supervisor of Advertising & Sales Promotion for the Acheson Colloids Co., Port Huron, Mich.

Klein & Saks of Washington, D. C., consultants to American industry and to foreign governments, have announced the appointment of R. L. Davies as Executive Director.

L. A. Bliss has been appointed President of the Union Carbide Nuclear Co., a Div. of Union Carbide & Carbon Corp., N. Y., N. Y.

L. C. Byck, Jr. has been named Manager of Heavy Chemical Sales for the U. S. Industrial Chemicals Co., N. Y., N. Y.

Dr. M. W. Aarons has joined the technical staff of Bjorksten Research Labs., Inc., Madison, Wis., as Senior Physicist in the Solid State Physics Section.

The Pennsylvania Salt Mfg. Co., Philadelphia, Pa., has completed the consolidation of its Sharples operations with the activities of the Industrial Chemicals Div. The new unit, known as the Industrial Div., will be directed by General Manager H. C. Land.

L. V. Taylor has been named Senior Product Engineer in the Research & Development Dept. of Crown Cork & Seal Co., Inc., with headquarters in Baltimore, Md.

K. Dunn, President of American Brake Shoe Co., N. Y., N. Y., has been elected Chief Executive of the company.

J. N. Hinyard has been appointed Director of Market Development for American Potash & Chemical Corp., Los Angeles, Calif.

Lubrication Abstracts

(Compiled by the ASLE Abstracts Sub-Committees.)

Change During Use of Behavior of Heavy-Duty Diesel-Engine Oils and Its Effect on Oil Change Periods, and Applicable Test Methods, The, by N. Kendall & L. G. Richards, "Schweizer Archiv.," Vol. 22, No. 8, Aug. 1956, pp. 261-269 (in German). The functions performed by additives to diesel-engine lubricating oils are discussed. Experiments designed to establish optimum additive concentration and oil-change periods are described. The various operating conditions affecting wear and cleanliness are then discussed, and a detailed description of the test engine used and selected operating conditions are given. The primary benefits obtained by additive oils are reduction in cylinder and piston-ring wear as well as improvements in engine cleanliness. Since corrosive wear is the greatest contributor to destructive wear, the addition of basic material to the oil will neutralize the acids formed in the combustion process. Radioactive wear tests are described which indicate that additive depletion occurs during extended engine runs. This is especially true of high-sulphur fuels. It is found that a correlation exists between wear and the level of alkalinity of the lubricating oil at the end of the test period. It is shown that the proper balance of various additives is important to effective maintenance of engine cleanliness by dispersant-type additives. (Translated and abstracted by L. Motulsky)

Combating Cylinder Wear & Fouling in Large Low-Speed Diesel Engines, by M. J. VanDerZijden & A. A. Kelly, "Inst. Marine Engrs. Trans.," Vol. 68, No. 8, Aug. 1956, pp. 272-278, discussion pp. 278-286. Crankcase oils of novel composition are evaluated in ex-

tensive laboratory and shipboard tests for their value in offsetting the corrosive wear of cylinders and rings when operated on low-grade fuels in ship-propulsion engines. These novel lubricants, containing water-soluble additives incorporated by emulsification, are shown to provide more effective anti-wear and engine-cleansing action than conventional heavy-duty lubricants containing oil-soluble additives. Contamination of the novel crankcase oil with sea water produces no adverse results. Engine type, operational schedule, fuel type and cleanliness, and maintenance practices may all be expected to influence wear rates with conventional or emulsion-type lubricants.

Line-Boring Rig Has Three Separate Bars, by C. T. Bower, London, "Machine & Tool Blue Book," Vol. 51, No. 9, Sept. 1956, pp. 114-120 & 122. A new boring rig for machining in line two groups of bearings of an open-sided casting is described. Each group consists of three split bearings. The center line distance between these groups must be maintained to a fairly high standard of precision. The new rig eliminates the need to remove and replace the bearing caps in setting up and taking down the casting, as was necessary with the old rig. This is accomplished by replacing each of the long boring bars on the old rig by three separate short bars with its own radial boring tool and each driven separately from a common drive shaft. These boring bars are contained in a fixture which facilitates the setting up of the casting. Greater tool life and production speed have been obtained with this new fixture. (Abstracter: H. N. Kaufman)

Lubricating Oil Reveals Wear in Pipeline Compressors, by J. L. Wilson & S. R. Sawyer, "Oil & Gas Journal," Vol. 54, No. 63, July 16, 1956, pp. 108-111. AGA-sponsored studies are described which correlate periodic emission spectrographic analyses of 75 used compressor-engine oils with engine performance. The objective is development of a method of detecting abnormal engine wear before failure. The oils and service data are contributed by 11 major gas-transmission companies. Silicon, iron, chromium, aluminum, copper, lead, tin, and boron are determined, and are used separately or in combination to give clues to wear or damage to engine parts. Most important is the correct interpretation of the analytical results, and care must be taken that the metals are not introduced from non-wearing members such as from gasket compounds, coolant-treating chemicals. Additional experience and knowledge should increase the value of the method in predicting engine difficulties. (Abstracter: N. C. Penfold)

Mechanics of Lubrication, The, by C. L. Pope, "Iron & Steel Engr.," Vol. 33, No. 9, Sept. 1956, pp. 130 & 131. The three basic types of lubrication — dry, boundary, and fluid film — are discussed. Examples are presented which show that dry lubrication might be preferred in cases where the use of a lubricant might cause abrasives to be carried to the bearing, or in cases where operating temperatures cause the breakdown of the lubricant. The characteristics of boundary lubrication and the types of bearing materials and lubricants suitable for such conditions are presented. Fluid film lubrication and its related problems are discussed. A discussion of rolling-type bearings, their characteristics, and a few of the general causes of their failure and methods of correcting these causes is included. (Abstracter: H. N. Kaufman)

Section & Use of Roll-Neck Bearings, by K. E. McHenry, "Iron & Steel Engr.," Vol. 33, No. 9, Sept. 1956, pp. 130 & 131. The essential properties which a bearing must possess are listed and defined. Characteristics of tin-base and lead-base babbitt bearings, grid-type bearings, composition bearings, and rolling-type bearings used as roll-neck bearings are discussed, with the advantages and disadvantages of each presented. (Abstracter: H. N. Kaufman)

Test Facilities for Inspectorate of Fighting Vehicles, "Engineering," Vol. 182, No. 4715, July 20, 1956, pp. 79 & 80, and "Engineer," Vol. 202, No. 5242,

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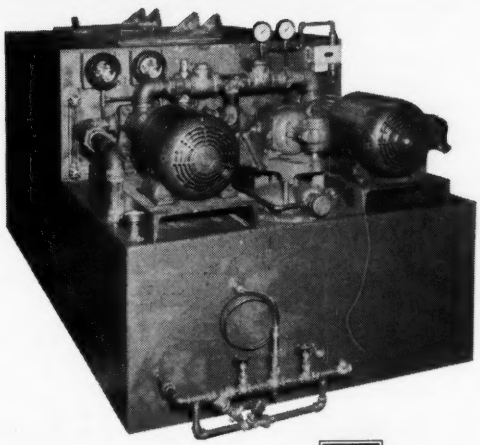

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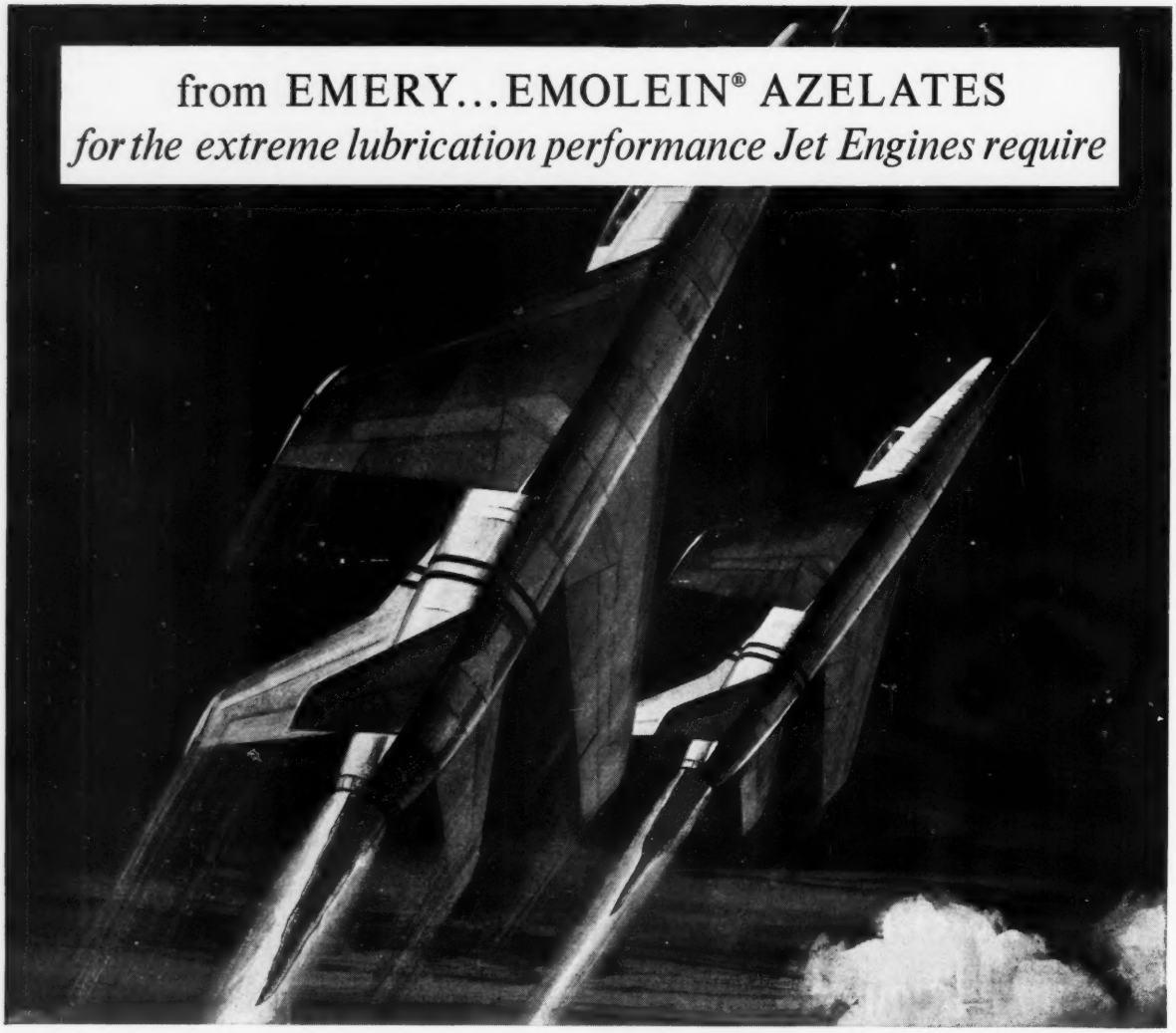

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(Lube Abstracts, from p. 107)
July 13, 1956, p. 56. Facilities of a new oil-test laboratory at the Inspectorate of Fighting Vehicles in England are described. Test engines include the Caterpillar single-cylinder diesel and Chevrolet which are used similarly in the USA for qualification of oils in accordance with military specifications. Supplementing these are pairs of Petter AV-1 diesels and Petter W-1 gasoline engines which are used as preliminary screening tools. Gear oils are evaluated in both a laboratory rig using a standard "Vanguard" rear axle operated under high-torque conditions, and in a test car operated under high-speed conditions. These tests are considered the equivalent of the high-torque and high-speed tests used for qualification of gear oils under MIL 2105 specifications in the USA. (Abstracter: N. C. Penfold)

Foreign Lubrication Abstracts=

(This is the tenth in a series of abstracts of translations of Foreign articles on lubrication, by Henry Brutcher. Copies of the full translations are available, at the indicated prices, by writing Mr. Brutcher at P. O. Box 157, Altadena, Calif.)

Mechanism of Action of Active Agents in the Cutting of Metals, by G. I. Epifanov et al; "Doklady Akademii Nauk SSSR," Vol. 97, No. 2, 1954, pp. 277-279; 1500 words. Concept of 'disintegrating action'; its usefulness in explaining a great body of experimental data on the effect of cutting fluids, more specifically, of active agents, on the deformation and disintegration of metals in cutting. Disintegration as result of catalysis of decomposition of cutting agents by the metal, and diffusion of the decomposition products, particularly hydrogen, into the metal lattice, causing the latter's disruption. Effect of oxygen, carbon, and nitrogen. Equation expressing the rate of heterodiffusion. Supporting evidence for proposed mechanism of disintegrating action of active cutting agents. (Order No. 3424, price $2.90)

Thermodiffusional Sulfidizing of Steels, by V. V. Gal'chenko; "Stanki I Instrument," Vol. 26, No. 2, 1955, pp. 17-19; 2 tables, 1600 words. Mechanism of action of FeS surface layer on steel or cast iron, produced by impregnation in salt baths containing compounds of sulfur and nitrogen, in lowering wear and preventing seizing and welding of structural parts in contact with each other. Effect of change in surface zone by sulfidizing upon frictional and other characteristics; electrostatic polarization of sulfidized case when under compression; and increase in its absorptive capacity for lubricants. Usefulness of sulfur in creating a buffer layer for lubrication and cutting. Currently used methods other than thermodiffusional sulfidizing, for minimizing friction and facilitating cutting. Results of extensive comparative tests of the various processes of sulfidizing, on a Timken-type wear-testing machine (Table II); steels used in tests include Mn steel with 0.23% S, 0.8% Cr structural steel, and bearing steel. (Order No. 3595, price $3.75)

Performance of Various Emulsions in the Cold Rolling of Strip Steel, by H. Pannek, "Stahl und Eisen," Vol. 75, No. 12, 1955, pp. 767-769; 2 tables, 3100 words. Principal requirements to be met by good emulsions for the cold rolling of steel. Investigation of six emulsions for their cooling action, rust-inhibition on coiled strip, annealing residue, lubrication residue, slime on emulsion, erosion tendency, and smell. Points scheme for assessing these properties (Table II); practical usefulness of scheme for drawing conclusions applicable at the rolling mill, as to fitness of any given emulsion. Includes written discussion by a lubrication engineer, analyzing the value of such an assessment as proposed by author. (Order No. 3639, price $5.90)

Sulfidizing of Gray Iron & Steel, by I. M. Engalychev & P. U. Zemskov; "Vestnik Mashinostroeniya," Vol. 36, No. 2, 1956, pp. 46-48; 4 figs., 2 tables, 1100 words. Sulfidizing gray-iron piston rings in aqueous and nonaqueous baths. Particulars on composition of three aq. and three anhydrous sulfidizing solutions, and results obtained with them. Penetration of sulfur into specimens as function of treating time (Figs. 1 & 2) and bath composition. Composition of the two gray irons studied; also tool steels. Wear testing procedure and results. Superiority of sulfidized over phosphated piston rings in continuously operating engines; sulfidized chrome-plated rings. Sulfidizing of cutting tools: 50-100% extension of useful life of drills obtained by treatment in two out of the three tested solutions. (Order No. 3744, price $2.90)

Influence of the Ratio of Areas of Friction upon Wear, by D. N. Garkunov; "Doklady Akademii Nauk SSSR," Vol. 104, No. 2, 1955, pp. 227-228; 1 fig., 600 words. Relationship between ratio of gravimetric wear of two materials in frictional contact (like with like and with unlike), and ratio of their surface areas of friction. Mutual abrasive wear of steel specimens as an example (Fig. 1). Four hypotheses underlying the author's explanation of this relationship. Nature of abrasive wear of metals, especially as affected by speed of movement. (Order No. 3764, price $1.50)

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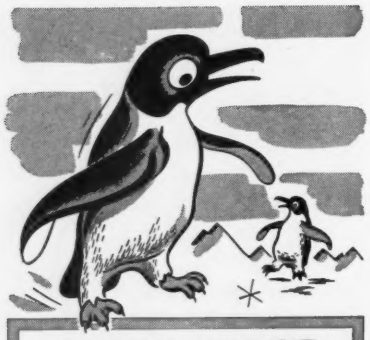

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Patent Abstracts

(Compiled by Ann Burchick, Aluminum Co. of America.)

Lithium Soap Grease with Phosphate Ester Vehicle, Patent No. 2,737,493 (R. A. Butcosk, assignor to Socony Mobil Oil Co., Inc.) A lubricating grease comprising: at least 60 percent by weight of a dialyl monoaryl phosphate ester vehicle, a lithium fatty acid soap (I) in an amount from about four to about thirty per cent by weight of the grease, and a metal salt (II) of a monocarboxylic aliphatic acid having from about six to about ten carbon atoms per molecule in an amount from about 0.2 to about ten per cent by weight of the grease, the metal of said metal salt (II) being selected from the group consisting of lithium and aluminum.

Stable Greases Containing Synthetic Gelling Agents, Patent No. 2,737,494 (F .C. Frank, assignor to Socony Mobil Oil Co., Inc.) A grease comprising an oleaginous vehicle and a salt in an amount sufficient to thicken said vehicle to form a grease, said salt being a metal salt of an acidic reaction product obtained by reaction of a compound selected from the group consisting of an aliphatic monohydric alcohol having at least about eight carbon atoms per molecule and an aliphatic monoamine having at least about eight carbon atoms per molecule, with an acidic copolymer of an alpha, beta unsaturated polycarboxylic acid and a low molecular weight organic compound having a terminal vinyl group and having less than about ten carbon atoms per molecule, such that from about fifty to about ninety per cent of the carboxyl groups of the acidic copolymer are reacted with said compound, said acidic copolymer having a molecular weight above about 1000, the metal of said salt being selected from the group consisting of metals of Groups I through III of Mendeleeff's Periodic System and a small amount, sufficient to reduce the tendency to stiffen on standing of a grease comprised of said oleaginous vehicle and said salt, of a polymeric material having an average molecular weight from about 10,000 to about 100,000, polymeric material being selected from the group consisting of an olefin polymer; an ester polymer; an esterified copolymer of an alpha, beta-unsaturated dicarboxylic acid anhydride and vinyl acetate; an esterified copolymer of a vinyl ether and an alpha, beta-unsaturated dicarboxylic acid anhydride; an esterified copolymer of an alkyl ether and an alpha, beta-unsaturated dicarboxylic anhydride; and an ester of a thiophene-modified, maleic anhydride-styrene copolymer.

Grinding Oil Containing Pyrophosphatidic Acid & Sulfur, Patent No. 2,737,495 (H. W. Johnston, assignor to The Standard Oil Co.) A composition comprising at least 88% by weight of a mineral oil base having a viscosity in the range of 150 to 300 SUS at 100 F., from about 0.5 to about 10% by weight of pyrophosphatidic acid and from about 0.25 to about 3.0% by weight of dissolved sulfur.

Lubricating Oil Compositions Containing Polymeric Additives, Patent No. 2,737,496 (W. E. Catlin, assignor to E. I. duPont deNemours & Co.) A petroleum base lubricating oil containing at least 0.1% by weight of an oil soluble, basic amino nitrogen containing addition type copolymer containing in combined form as its essential monomeric components copolymerizable ethylenically unsaturated compounds each containing only one polymerizable thylenic linkage, at least one of which components is amine-free and contains from 8 to about 18 carbon atoms in an aliphatic hydrocarbon chain which in the copolymer is not part of the main chain, and one of the components as it exists in the copolymer containing a basic amino nitrogen in the side chain, said copolymer containing 0.1% to 3.0% by weight of basic amino nitrogen, said copolymer having an inherent viscosity of 0.1 to 3.0 as determined at 0.1% weight/volume concentration in benzene at 25 C., and said copolymer being one which does not contain as a component a N-hydrocarbon-substituted acrylamide.

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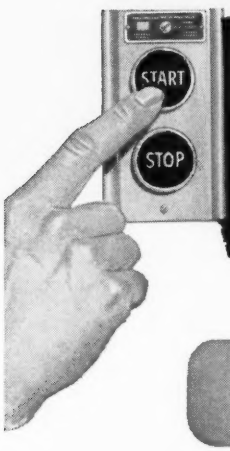

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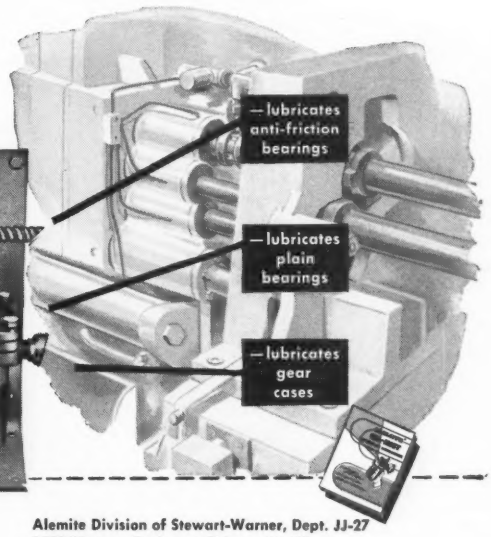

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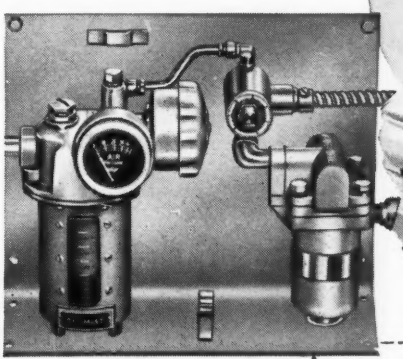

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